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3, Amersham Road, HIGH WYCOMBE, Bucks.
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The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

The Foundry Trades' Equipment and Supplies Association

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W. B. Lake, J.P., Lake & Elliot, Limited, Braintree, Essex.

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BRITISH CAST IRON RESEARCH ASSOCIATION
The Registered Office and Laboratories of the B.C.I.R.A. are:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone; Colmore 4274-4275 Telegrams: CIRA
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone: 332

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The Field

In order not to embarrass those who are endeavouring to rationalise the ironfoundry employers' interests, we are refraining for the moment from commenting on the present situation, but in the hope that they may be useful at the present juncture, we are putting forward for consideration some theoretical concepts of the organisation of an ideal association. We do this because we feel that the weaknesses so far shown have been due to a belief that there is such a sparcity of common interests in the industry as to make national co-operation not really worth while. A common notion was that the only real tie was the fact that all ironfounders use pig-iron. One of the objects of what follows is to put into relief the present and ever-growing list of factors which impinge upon the industry as a whole. To make matters clear, we have envisaged a really nationally representative body and for its efficient working have constituted the following committees: Finance and House; Political and Legal; Technical; Personnel; Efficiency and Membership; and Publicity.

The work of the Finance and House Committee—important though it be—needs no comment from us. At the present time, the duties devolving upon the Political and Legal Committee are of such a nature that the immediate availability of a high-grade lawyer is almost a prerequisite. This is due to the fact that the exigencies of the war are such that no warning is given before an edict is promulgated and early representation is essential if anomalies are to be cleared up and hardships mitigated. The Ministries of Labour and National Service, of Supply, and of Food, and the Board of Trade are all liable to enact new legislation impacting upon the foundry industry as a whole or upon important sections. In less hectic times, advice upon Customs of the Trade would be a very useful activity. We suggest the work of the Technical Committee should be—at the moment—of an advisory body, or clearing house. It would advise members on such subjects as the acquisition of orders, the farming out of surplus orders, the overcoming of manufacturing difficulties, the ensuring of adequate representation on committees preparing specifications and their scrutiny in the provisional stages, and the general survey and direction of industrial research carried out nationally and in the laboratories of raw material suppliers.

The functions of the Personnel Committee would be to supervise the recruitment of apprentices to the industry, to deal with the Ministry of Labour and National Service, *before* enactments are made, leaving it to the Political Committee to straighten out existing anomalies; to co-ordinate the work of the Central Register, to examine cases of "poaching," to advise upon departmental appointments, and to help with the staffing of the new armament foundries.

The work allocated to the Industrial Efficiency Committee is obviously of outstanding importance, because one section of the community is obviously endeavouring to make "inefficient management" the main plank in their political platform. We have given some thought to this question and have reached the decision that practically every case can be attributed to faulty rate fixing consequent upon inadequate costing systems. Thus their first duty must be to make available and popularise by every possible means, a nationally unified costing system, and moreover to find means for insisting that the system devised is rigidly adhered to. Other work which would be delegated to the committee would be negotiations with the suppliers of raw materials, such as pig-iron, scrap and coke, and with the transport companies.

The last committee on our list is that of covering membership and publicity. Much of its work is obvious, but it should be remembered that under normal conditions, several new concerns are registered each week and to ensure that the interests of the industry are not inadvertently injured by these new companies, contact with them should be made initially. We well remember the period when a lengthy order-book built up on quite unremunerative prices was the sole structure of more than one of these mushroom firms. Moreover, the people financing these concerns were often unaware of the rotten nature of their purchase until they had been trading for several months. During this time they not only lost their own money, but damaged the fabric of many other firms.

We submit that all the activities we have outlined affect directly or indirectly the whole of the industry. Yet for the efficient conduct of an ideal organisation, these committees would need reinforcement by either affiliated bodies or committees covering district activities and sectional interests. We sincerely trust that the above concepts will help and not embarrass that small band of enthusiasts who are working so hard to build up an organisation acceptable to every member of the industry.

Foundry Trades' Equipment and Supplies Association

MR. G. E. FRANCE RE-ELECTED PRESIDENT

The Annual General Meeting was held last Wednesday week at Grosvenor House, Park Lane, London, W.1. It was preceded by a luncheon, at which two guests, Dr. Colclough and Mr. F. Broadbent, were present.

After the notice convening the meeting had been read, the Annual Report was adopted.

Annual Report, Year ending December 31, 1940

At the last Annual General Meeting, held on April 4, 1940, a Sub-committee was appointed consisting of the President, Mr. Barrington Hooper, and Mr. Cherry Paterson, to produce a programme for the "future conduct and development of the Association." The Sub-committee produced a report which was circulated to every member at the beginning of May, 1940, and which was considered by a General Meeting of the Association held on May 9, 1940. That meeting accepted the report in principle, and a further Sub-committee consisting of Mr. France, Mr. Barrington Hooper, Mr. Paterson, Mr. Turner and Mr. Wood, with power to co-opt, was appointed to devise schemes to put into effect the principles involved in the report of the original Sub-committee.

About the same time, Mr. France had been asked by the Export Council of the Board of Trade, insistently and urgently, to organise an export group for the Foundry Equipment Trade, and the inaugural meeting of that group was to be held in the afternoon of May 9, and the General Meeting of the Association resolved to offer Mr. France and the export group of the Association facilities in fathering the group. The group was duly inaugurated on the same day with Mr. K. W. Bridges as Secretary.

Unfortunately, shortly after this, Mr. Bridges was called up for service with His Majesty's Forces and had to resign his Secretaryship of the export group. He continued as Secretary of the Association, however, the secretarial work being undertaken from that time by his Secretary, Miss Cox, who has carried out the work exceedingly well. In August, 1940, the Ministry of Food approached the Association with a view to the Association acting as Dextrine Control of the Starch Section of the Ministry. The Ministry apparently felt that the Association was the appropriate body for this work. From then onwards the Association has indeed been the Dextrine Control, and has cared for the requirements of upwards of 160 consumers of this commodity.

The accounts are presented herewith, and appear in themselves to be quite clear. It is regretted, however, that there is again an excess of expenditure over income. Membership has been fully maintained, and at the end of 1940 was twenty.

The balance sheet showed a loss of just over £22 on the year's working, but as the liquid assets of the Association amount to about £300, the financial position is extremely sound.

A letter was read from Mr. K. W. Bridges asking to be suspended from the position of honorary secretary, as his military duties prevented him from giving the necessary attention to the business of the Association. In view of this, Miss L. Cox was appointed Acting Honorary Secretary for the duration of the war.

As allocations officer to the Dextrine Control, Miss Cox outlined the nature of her duties and the cost of its operation. A small levy on the consumers had been made, and in future the accounts germane to the control would be included in the annual financial statements of the Association.

Mr. G. E. France was re-elected President for the third time, as it was felt that his services would be especially valuable to the Association on the conclusion of hostilities, when a reorganisation on the lines of the report of the Sub-committee is envisaged. Mr. E. J. Penston was re-elected vice-president, and the retiring members of the Council were also re-elected. At the conclusion of the meeting Mr. France was very cordially thanked for his work on behalf of the Association. In his reply, the President expressed the gratitude of the members to Miss Cox for her efficient conduct of the Dextrine Control.

High-Duty Cast Irons

The Research Committee of the Institute of Mechanical Engineers on High-Duty Cast Irons for General Engineering Purposes have compiled certain monographs on special-duty irons, for the guidance of engineers engaged in the design of castings or in foundry work. The following monographs, which will shortly be ready, will be published under one cover:—(1) Types of Cast Iron: A Report on Austenitic and Martensitic Special-Duty Cast Irons; (2) Report on Austenitic Cast Irons; and (3) Report on Martensitic Cast Irons.

The Committee have now also completed their Second Report, dealing mainly with phosphoric irons, on which written discussion is invited. Advance copies of this report will be available shortly. The three monographs, as well as the Second Report, were prepared for the Committee by the reporter, Mr. J. G. Pearce, M.Sc., M.I.Mech.E.

War Risks Insurance of Iron and Steel

The Board of Trade announce that as from July 3, 1941, each of the various categories of iron and steel in Heading 17 of Group "C" of the War Risks Insurance Act, 1939 (Part II), will be treated as a separate heading for the purposes of insurance under Group "C." Hitherto, if a person desired to insure any of the categories under Heading 17 of Group "C" he was compelled to insure as for all covered by that heading. The various categories have now each been given a separate designation from 17A to 17R, and a person can insure any one or more of the categories without having to cover all. The categories and designations are as follow:—

17.—Iron and steel of the following descriptions: 17A, pig-iron. 17B, ferro-alloys, other than in powder form. 17C, ingots, billets, blooms and slabs; tinplate bars and sheet bars. 17D, plates, coated or uncoated, whether fabricated or not. 17E, sheets, coated or uncoated; tinplates, terne plates, black plates and silver finished plates. 17F, angles, channels, tees, joists, piling sections and other sectional material, whether fabricated or not. 17G, goods of the following descriptions (not including bright steel): Rounds, rods, wire, rods, squares, hexagons, flats and all other sections and shapes. 17H, bright steel goods of the following descriptions: Rounds, rods, wire rods, squares, hexagons, flats and all other sections and shapes. 17J, bolts of ½ in. in diameter and over, unmachined; rivets of ½ in. in diameter and over, unmachined. 17K, rails, sleepers, fishplates and sole plates. 17L, hot rolled hoop and strip. 17M, cold rolled hoop and strip. 17N, tyres, axles and wheels. 17O, goods of the following descriptions (not including bolts, rivets, nuts, washers, screws or spikes): Iron castings (except where wholly or partly machined); steel castings; forgings; stampings (except where wholly or partly machined); pressings. 17P, colliery arches and pit props. 17Q, hot finished wrought-iron and steel tubes and standard fittings therefor, however made; cast-iron pipes and standard fittings therefor; malleable cast fittings for pipes and tubes. 17R, assemblies of plates and sectional materials as component parts of structure.

Random Shots

It is sad to think that the longest day ha already gone by, for these long evenings ar proving a perfect boon and joy to all hard working folk. Be it one's pleasure to spen them debugging the garden or going down t the river, it is not so much the darkness tha drives one indoors, but rather that pleasan fatigue which calls for "just half a pint and s to bed."

* * *

Incidentally, "The River," be it the Thame or any of the lesser (though equally beloved fry, is proving a very special attraction th summer, when so few people are "going away for a river provides a diversity of activiti which are furthest removed from everyday wor and nearest to the usual annual seaside sport And what a diversity is there! There are th physical joys of rowing and swimming an punting; the technical pleasures of motor boa ing and sailing; or the sheer release from effo of any kind, either mental or physical, to b found in spending a day going for a trip on steam launch or sitting on the bank pretendin to fish.

* * *

Apropos of rivers, the publication last wee of the will of the original "George" of J. K Jerome's book "Three Men in a Boat" is a apt reminder that the present popularity of th river is only a revival of a former fashio which declined for a time with the rising popu larity of Youth's new mechanical toy, the sma car. It is a coincidence that "Marksman" h only just finished re-reading "Three Men in Boat" for the three-dozenth time, and as change from trying to understand and trying do something about the present state of th modern Babel, it is thoroughly to be recom mended.

* * *

Moulders are rightly very worried about th clothes rationing scheme. It appears that the normally cast their clouts as quickly an thoroughly as they cast their metal.

* * *

On hearing his father say that Messrs Feinmesser & Donowt's employed at lea 10,000 hands, young Johnny exclaime "Gosh, what a lot! That must mean 5,00 men."

* * *

"Marksman" has been getting into troub with a Scottish national enthusiast for sayin that Hess flew to England. It is obvious tha to be fair to one and all alike, the story shoul have read: "Herr Hess flew to the Unite Kingdom of Great Britain and Northern Ir land and alighted in Scotland." But sometime in trying to please everyone, life becomes to too complicated.

* * *

Yet another story of the frailties of that mus maligned creature, the moulder, was told b Mr. George Hall in a recent address as chair man of the East Anglian Section. A moulde starting at a new job, was told to make a pi trough. The casting was a waster. "Neve mind," said the foreman, "have another shot a it." Next morning there was the same sad stor and the same encouragement from the foreman However, on the third morning the moulde met the foreman and got his word in firs "Now look 'ere, Guv'nor," said he, "those pig will have to eat off the floor, because I'm damned if I'm going to make them a trough."

* * *

Mrs. Malaprop is not so keen on "the public swimming baths." The chlorodyne i them gives her daughter the tummy-ache.

* * *

Seen in a dry-cleaner's window:—

"If you've been bombed bring your blaste clothes here." "MARKSMAN."

Some Factors Affecting the Resistance of Cast Iron to Deflection under Load at High Temperatures*

By L. W. BOLTON, A.M.I.Mech.E. (British Cast Iron Research Association, Birmingham)

Ordinary grey cast iron fails at high temperature through growth and scaling, but special irons have been developed in recent years which possess resistance to a marked extent to both these effects. The extended application of these irons in industry has made it desirable to have some information regarding their resistance to deformation under prolonged application of light loads at high temperatures.

The work described in this report was carried out with a view to supplying some of this information, and since the results of quantitative creep tests at high temperatures are extremely difficult to interpret for purposes of design, it was felt that the work should not be confined to actual creep tests on the special irons, but rather should be designed with a view to studying the influence of composition, structure and castings conditions on this phenomenon. In this way it was hoped to obtain data on the relative resistance to deformation under load at high temperatures of various types of heat-resisting cast irons which are now available.

Most heat-resisting cast irons have a fine graphite structure, and some owe their qualities to the presence of an abnormally high silicon content (*i.e.*, more than 4.5 per cent.). Others are austenitic, and consequently are far less rigid at room temperature than pearlitic or ferritic irons. It is sometimes desirable that the irons contain a moderate quantity of phosphorus in order to improve the castability of the metal. For these reasons, special attention has been given in this work to the influence of graphite size, variations in silicon and phosphorus contents, and to alloying employed to the extent of rendering the structure of the iron austenitic. Some data on carbon steels of varying carbon content have also been obtained.

For the purpose of this exploratory work, a method of testing has been developed which consists essentially of transverse-loading a bar of standard dimensions at one end, while the other end is rigidly held, the stressed portion of the bar being held at a predetermined constant temperature. Details of the apparatus used and the method of carrying out the test are described below. After consideration of the various in-

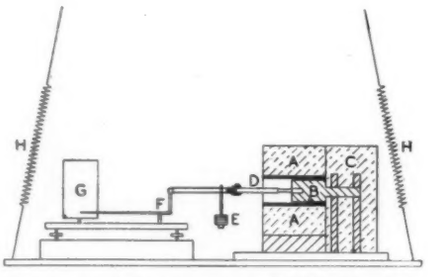


FIG. 1.—APPARATUS FOR EXAMINING THE RIGIDITY OF CAST IRON AT ELEVATED TEMPERATURES.

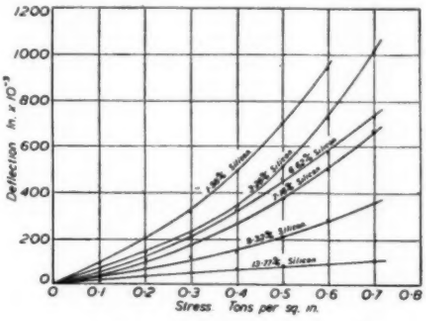


FIG. 2.—DEFLECTION OF SERIES *A* BARS AT 850 DEG. C.

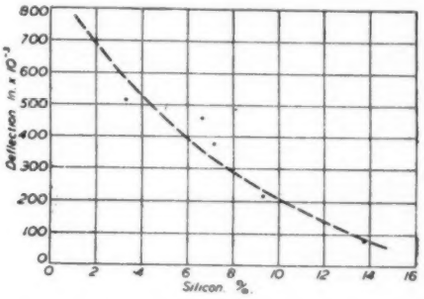


FIG. 3.—DEFLECTION OF SERIES *A* BARS AFTER 5 DAYS WITH TOTAL STRESS OF 0.5 TON PER SQ. IN. AT 850 DEG. C.

* Report on a research carried out with the aid of a grant from the Andrew Carnegie Research Fund, and presented as a paper to the Iron and Steel Institute.

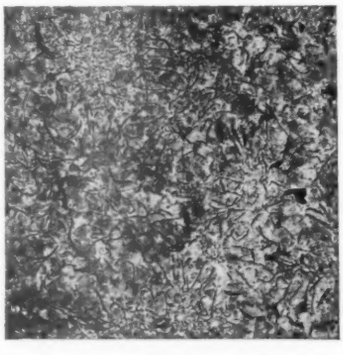


FIG. 11.—SILICON, 1.98 PER CENT.

FIG. 12.—SILICON, 3.28 PER CENT.

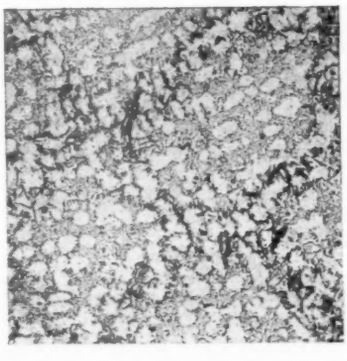


FIG. 13.—SILICON, 6.62 PER CENT.

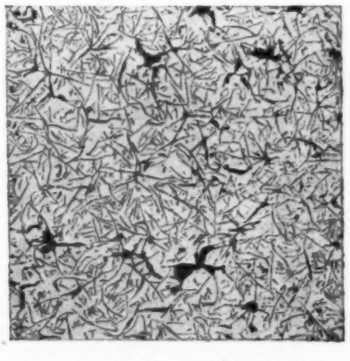


FIG. 14.—SILICON, 7.16 PER CENT.

Figs. 11 to 14.—Etched in picric acid.

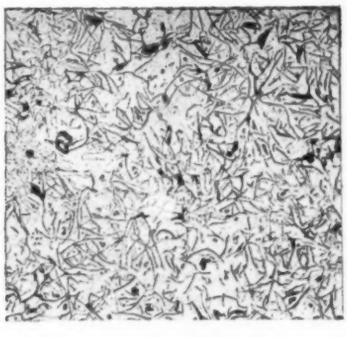


FIG. 15.—SILICON, 9.32 PER CENT.

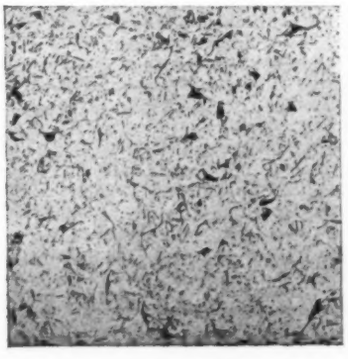


FIG. 16.—SILICON, 13.77 PER CENT.

Figs. 15 and 16.—Etched in 40 per cent. HF, 20 per cent. HNO_3 in glycerine.

Figs. 11 to 16.—Increasing silicon, Series *A*, 0.65-in. dia. bars. Mag. 75.

dustrial applications in which cast iron is used at high temperatures, it was decided that information was most needed on its resistance to deformation at between 800 deg. C. and 900 deg. C. A temperature of 850 deg. C. was therefore chosen for the investigation.

Apparatus and Method Employed

The layout of the apparatus used is shown in Fig. 1. The specimen (D) is a bar 7 in. long and 0.6 in. in dia., reduced to 0.5 in. in dia. for a distance of 1 in. near one end, for the purpose of localising the stress. One end of the bar is rigidly held in a heavy heat-resisting nickel-chromium-alloy holder (B), clamped to the base of the apparatus by means of stout cast-iron brackets. The test-piece is loaded at the free end with weights (E), and a system of levers (F) amplifies the movement of the pointer at the end in the ratio of 10 to 1, this movement (*i.e.*, deflection at the free end) being recorded on a moving drum (G). In order to eliminate the effects of vibration, the whole apparatus is suspended on springs (H). The test-piece is raised to, and maintained at, the required temperature by means of a resistance furnace (A), well lagged with kieselguhr. On account of the massive size of the holder (B) the rest of the apparatus was also thoroughly insulated with kieselguhr and slag wool (C). The temperature of the specimen was obtained by means of a platinum/platinum-10 per cent.-rhodium thermocouple, the hot junction of which could be moved along the bar for a distance of 1 in. The furnace temperature was not thermostatically controlled, but the variations in temperature did not exceed ± 7 deg. C., and these variations were found to be without effect on the manner in which the bars deflected under load.

In carrying out the test, the furnace was slowly raised to the required temperature, and a steady temperature state was reached in approximately 5 hrs. from the time of switching on the furnace. During this heating-up period, the test bar was supported at the free end to prevent any sagging under its own weight. The weights used at the free end were such that the transverse stress at the narrowed part of the bar near the fixed end could be increased in steps of 0.1 in. per sq. in. from 0 to 2 tons per sq. in.

The effect of applying a load at the free end of the bar was to cause a fairly rapid rate of deflection for the first 3 or 4 hrs., but after this the rate of deflection gradually decreased and then remained constant. At the end of a 24-hr. period, the load was stepped up by an increment of 0.1 ton per sq. in., which was maintained for another 24 hrs., and this process was repeated until the bar had bent through an angle of approximately 10 deg. It is worthy of note that even the most brittle of cast irons, such as the high-silicon and high-phosphorus irons, were found to deform to this extent at 850 deg. C. without breaking.

The tests carried out showed that the section of the bar as-cast had a considerable influence on the manner in which the test-piece was deformed under load at high temperature. It was found, for instance, that test-pieces machined from thick cast sections were less rigid than those machined from thin sections of the same iron, and, in interpreting the results, this factor has to be taken into consideration.

Influence of Si on Rigidity of Cast Iron at 850 deg. C.

The ordinary common grey iron of medium silicon content, often used at high temperatures, usually fails ultimately from scaling and growth. Norbury and Morgan[1] have shown that if the graphite can be kept in a fine state of division, high-silicon cast irons have resistance to scaling and also a marked resistance to failure from growth. Such irons, having an Si content of approximately 5 per cent., together with a fine graphite structure, are known as Silal. The influence of additions of silicon to cast iron is well known, the matrix becoming harder and more brittle with increasing Si. The eutectic carbon content is reduced and the high-silicon cast irons with a silicon content of 14 per cent. to 16 per cent., used at present mainly for their resistance to chemical attack, contain usually less than 1.0 per cent. T.C, even when melted in contact with carbon, *i.e.*, in the cupola.

A series (A) of bars with increasing Si contents, ranging from 2 per cent. to 14 per cent., was tested, the actual compositions being given in Table I, and the results of the tests are plotted in Fig. 2. The cast size of the bars was 0.65 in. in dia. All the bars were cast in green-sand moulds from metal melted in a coke-fired crucible furnace. The crucible charges were made up from mixtures of Swedish white iron (3.8 per cent. T.C), Armco iron, ferro-silicon (10 per cent. Si), and ferro-manganese (80 per cent. Mn), to yield the desired composition. After the charge had melted down, the metal was superheated for approximately 15 mins. and then skimmed and poured.

It will be seen from the curves in Fig. 2 that Si exerts a stiffening influence on cast iron at the temperature of the tests. The microstructures of the bars are shown in Figs. 11 to 16. The iron containing 6.62 per cent. Si is of the Silal type and contains graphite in a finely divided state, as will be seen from the structure (Fig. 13). The graphite flakes in the 13.77 per cent. Si iron are also small, but those in the other two high-silicon irons are relatively coarse. This fact will be examined later in the section on graphite size. Fig. 3 shows deflections plotted against Si at a load of 0.5 ton per sq. in., *i.e.*, total deflection at the end of the fifth day of the test in each case. This shows clearly the increase in the rigidity of the irons as the Si is increased.

Air was able to enter the furnace during the tests, and this led to some scaling and growth,

(*Continued on page 7.*)

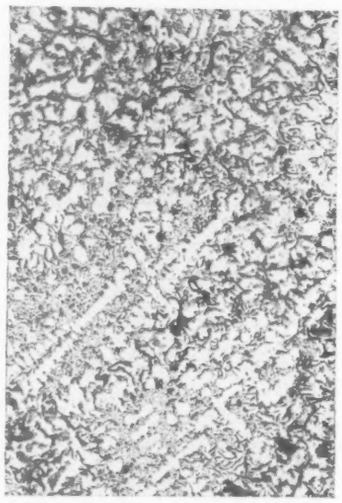


FIG. 17.—P, 0.377 PER CENT.

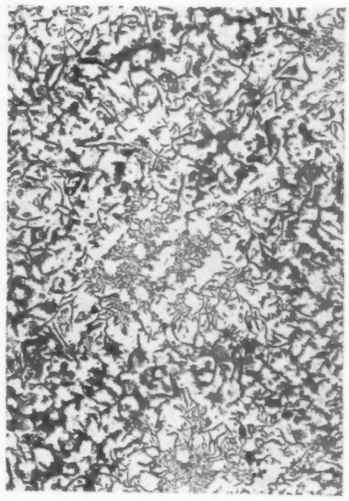


FIG. 18.—P, 0.639 PER CENT.

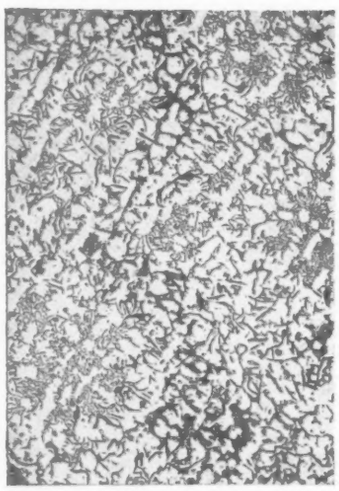


FIG. 19.—P, 0.927 PER CENT.

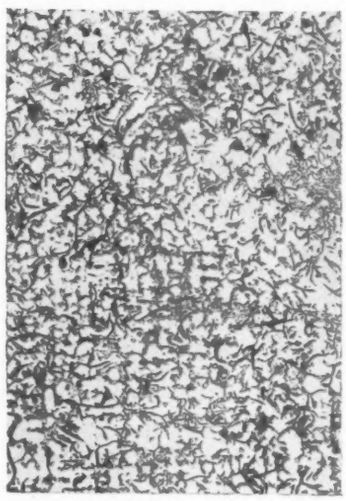


FIG. 20.—P, 1.100 PER CENT.

Figs. 17 to 20.—Increasing phosphorus, Series *B* (Si, 5.5 per cent.), 0.875-in. dia. bars. Etched in picric acid. Mag. 75.

TABLE I.—*Compositions of Irons, Series A (Increasing Silicon Contents).*

No.	T.C.	Si	Mn	S	P
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1	3.10	1.98	1.16	0.034	0.022
2	3.33	3.28	0.75	0.019	0.067
3	2.15	6.62	1.19	0.028	0.034
4	2.67	7.16	1.17	0.031	0.031
5	1.63	9.32	1.19	0.011	0.100
6	1.07	13.77	1.09	0.014	0.125

[1] A. L. Norbury and E. Morgan, "Journal of the Iron and Steel Institute," 1931, No. I., p. 413.

Current Foundry Problems

EAST ANGLIAN DISCUSSION

The first meeting of the new session was held at the Crown and Anchor Hotel, Ipswich, on June 14. In the earlier stages, Mr. H. H. Shepherd presided.

MR. H. H. SHEPHERD, in relinquishing the chair to Mr. George Hall, said the new chairman had been a member of the Institute for 20 years and had held office in London and the West Riding of Yorkshire before joining the East Anglian Section. His successor was a thoroughly practical foundryman, who had taken much more interest than most in the metallurgical aspect of foundry work. He was one of the pioneers of the "Perlit" system.

MR. HALL, on assuming the chair, paid a tribute to the outstanding work of the retiring President, Mr. H. H. Shepherd. For two years he had not only kept the Branch together during this trying period of war, but had left it with an increased membership. He recalled the cheery letters sent out by Mr. Shepherd during the early days of the war. He impressed upon the members the debt they owed to the secretary, Mr. Francis, for his untiring efforts and his affable manner of just doing and saying the right thing at the right moment.

Presidential Address

A formal vote of thanks to Mr. Shepherd and Mr. Francis being carried, Mr. Hall then delivered his Presidential Address, in the course of which he said:—

Mr. Shepherd and Gentlemen,—I propose calling my address "Twenty Years with the Institute." I shall endeavour, primarily, to recount some of my experience during the twenty years of membership, and tell you how that experience has been gained, *largely for the benefit of the young members of the Institute.*

The year 1921 found me manager of the Croydon Foundry, having already supervised the building and layout of plant. During the time of building, there was a competition arranged and a prize offered for the best design of a small ironfoundry, sponsored by THE FOUNDRY TRADE JOURNAL. My employer and I entered this competition and sent drawings and reading matter in support of our entry, but my esteemed friend, Mr. Tibbenham, beat us by a short head and carried away the first prize.

Shortly after the Croydon Foundry started production, Mr. Faulkner visited the works. I well remember his words to me, which were, "We want practical men like you in the Institute. Will you let me propose you?" I joined the Institute the same week. The London Branch was a live concern in those days, and good lectures were given. Some of these, I thought, were far too highbrow, as they were rather dry and of no apparent personal use in my business. (Do you sometimes think likewise? I am afraid some of you do!) However, I soon lost this opinion of highbrow lectures, for when I asked questions, it always resulted in some very satisfactory and helpful answers being received.

In 1922 I was elected to the London Branch Council, and subsequently we had some very interesting visits. The first one was to Lake & Elliott, of Braintree, which, apart from the tea and friendly meeting, was neither interesting nor enjoyable. It was on a Saturday afternoon that we slowly accomplished a monotonous journey to Braintree through thick fog. We arrived just in time to accept Mr. Lake's kind invitation to a very enjoyable tea, and had to leave shortly afterwards in order to catch the last train back to London. During my stay in the London Branch I had the privilege of coming into close contact with the late Mr. Ronceray, and enjoyed several bouts with him at his lectures. His famous pencil runner was well discussed, and was later tested by some of us in the workshop with comparative success.

In 1926 I left London for Birkenhead. Although nearly forty miles from Manchester, I was fortunate enough to be able to attend most of the meetings and social functions of the Lancashire Branch. I made more friends at that time than I had ever made before. There is a large number of practical men in that Branch; everybody is encouraged to take part in the discussions, and one is always sure of a good welcome. I bring to mind one member of that Branch, Mr. A. Sutcliffe, who would always take part in the discussions, and he and I were often in opposition. He is now, without doubt, one of the most popular members of that Branch. I note in THE FOUNDRY TRADE JOURNAL of May 1 that the Lancashire Branch have made him a presentation in recognition of his valuable contributions to the discussions during the past year. Mr. Sutcliffe, as a foundryman, knows his job; yet, even so, he still seeks knowledge.

It was in the early part of my stay in Lancashire that I became acquainted with several of our leading metallurgists—Mr. H. J. Young, Dr. J. E. Hurst, the late Mr. Victor Stobie, Mr. J. S. Primrose, and, of course, the secretary of the Institute, Mr. Makemson. When Mr. J. Cameron was absent, through illness, from the Lancashire Branch annual dinner, I accepted the honour, owing to the insistence of the then President, Mr. Faulkner, who would brook no refusal, of deputising for him in proposing one of the toasts.

About 1932 I went to Yorkshire and attended the first meeting of the session of the West Riding Branch. At that meeting the genial secretary, Mr. Wise, had so arranged matters that I was soon serving on the Council. At about that time, a small group of the members were determined to make the West Riding Branch prominent in the affairs of the Institute, and they worked with that end in view. In the last year of my stay in Yorkshire I was elected Senior Vice-President. I shall always regret leaving before having the opportunity of serving the West Riding Branch as President. However, in 1938 I had the pleasure of attending the Institute Conference in Bradford, when Mr. Joseph Hepworth, M.P., a member of that Branch, presided over the Institute.

In 1936 I came to Essex, and in May of that year there was the inaugural meeting, which resulted in the formation of the East Anglian Section. I was very proud to take part in that meeting, as I could see a chance of continuing to carry on in the Institute without having to travel a distance of fifty miles to London to attend a meeting. Nevertheless, I still have to come thirty miles to attend, but, I can assure you, it is worth it, because one can participate, if one so desires, without feeling an outsider.

During the whole of the twenty years that I have rendered what little service I could to the Institute, I have only had sufficient courage to produce two Papers—the first in London and the second in Yorkshire, which was repeated at Burnley.

I derived from being a member of the Institute many valuable friends, a welcome in any Branch I care to visit and twenty very important volumes of foundry literature in the form of the Proceedings. Most important of all, though—the greatest pleasure I could wish, and that is the honour you have done me in asking me over to preside at your meetings.

I particularly want the members, who have joined the Institute in the past year or two, to make their presence felt by asking questions at lectures. Accept in good heart what may appear to be dry and try to believe there is something in it for your benefit, in the same way as I have done. You must profit by it! Ignore what anyone may tell you about the Annual Conferences only being for the executives. If it is within your power to attend, do so; you will not regret the experience. You will meet there eminent members such as you have here in your own section. To name only a few—Mr. Lake, Mr. Shepherd, Mr. Kain, Mr. Tibbenham and Mr. Francis.

To our chemists and metallurgists I tender my thanks for much of the knowledge I have received from their lectures. All this has helped me during my twenty years' membership to make such progress as I have as a foundryman, both in business and the Institute generally.

There is a saying, "The man who blows his own trumpet never gets into a good band." Exception, of course, proves the rule; I have got into a good band, and, not only that, but have been entrusted with the baton.

INFORMAL DISCUSSION

Economy and Salvage in the Foundry

MR. D. CARRICK opened the discussion on this topic by explaining that, apart from reduction of scrap and wasters, he envisaged economy of materials such as sand, core oil, fuel, mould dressings, sprigs, wrought iron, etc. The supply and maintenance of measuring equipment in good order was one means of conserving materials by using the exact minimum quantities and avoiding guessing. He considered that much could be done in keeping sand mixing plant in first-class condition and cutting down the addition of new sand or binder. Maybe core washes could be displaced by the use of a finer core sand. Facing sand is often employed to excess and sand sent to the shake out adhering to castings is wasted. Consideration as to the best place in the sand system to add coal dust should be made in order to avoid losses by air currents and to get proper incorporation. He thought, too, that something could be done in rounding off corners on sprues and runners with a view to cutting down the metal going into these, thereby getting a higher ratio of castings to metal melted. Sprigs and chaplets could be salvaged by magnetic separation. Broken cores ought to go back for regrinding and a more careful check-up instituted on the issues of protective clothing, such as spats, goggles, gloves, etc., to operators. Often, too, there was a wasting of power and lighting, leakage of compressed air should not be allowed, and shot blast grit was lost if allowed to remain in hollow castings.

The CHAIRMAN said that time would not allow of anything like an adequate discussion of all the important points raised by Mr. Carrick, who ought to be invited to present a Paper on the subject. No man should be allowed to mix his own sand, and it was the practice in his foundry to make men sign against a date for any article of protective clothing issued.

MR. R. D. CHEYNE gave an instance of a foundry where a plant had been put into operation for reclaiming sand. During the first year of working the consumption of new sand had fallen from 300 to 130 tons.

MR. J. KING said that he favoured wrought iron gaggers rather than cast iron and that these should be issued to a moulder as part of the tackle allocated to him with each job.

MR. L. TIBBENHAM (Past Section President) agreed that Mr. Carrick should certainly be requested to amplify his remarks in the form

(*Continued on page* 8.)

Brake Drums

GREY CAST IRON AND MEEHANITE

By OLIVER SMALLEY, O.B.E.

(*Concluded from page* 427.)

Test Drum No. 4

Of this series of test drums, one more might be considered in that the use of such materials as nickel, copper, and molybdenum in combination with small quantities of chromium are commonly recommended in cast iron for heavy duty lorry and bus drums where strength, high resistance to thermal checking and scoring are most important. Unfortunately, most alloy drums contain only too frequently some free cementite, and whilst this may not be massive, nevertheless its effect under the tests now being considered is of more than ordinary interest. The composition of the series of drums used was:—T.C, 3.26; Si, 1.92; Mn, 0.86; S, 0.098; P, 0.108; Ni, 1.23; and Cr, 0.25 per cent. The actual Brinell taken from the drums themselves was 227, and the tensile strength approximated 18.8 tons per sq. in.

Fig. 31 shows that the graphite structure is, on the whole, good. It is not so good a structure as Fig. 14, but is distinctly better than Fig. 25. Figs. 32 and 33 reveal the etched structure at 100 and 500 magnifications respectively. As would be expected, they display an

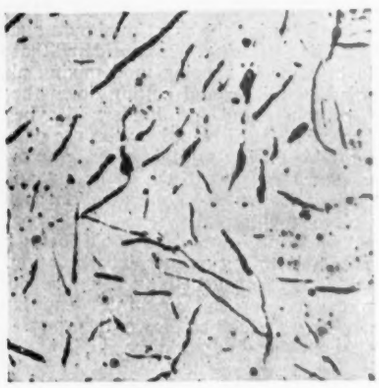


FIG. 31.—STRUCTURE OF GRAPHITE. (MAG. 100.)

exceptionally good close type of pearlite as would confer superior resistance to scoring, whilst the cementite patches are of minute form and well distributed. Such a structure would be acceptable to most foundry engineers experienced in the manufacture of alloy brake drums. The appearance of this drum after dynamometer tests is shown in Fig. 34. It has a low rating in resisting thermal checks, but obtained a high rating in the scoring test.

Figs. 35 and 36 taken at 100 and 500 magnification respectively indicate that thermal cracks in this iron were less inclined to follow the graphite flakes than in the previous sample. The normal surface seemed to hold up until once the cracks were formed and then they penetrated deeply into the interior of the drum. In this example penetration of the cracks was deeper than in any of the others tested.

Fig. 37 shows the structure of the surface of the drum at 500 magnification after the thermal check test, indicating that the pearlite resisted decomposition better than any other example cited. The presence of the heavy coating of oxide of iron surrounding the cracks clearly reveals the high temperature this drum must have reached in test.

SUMMARY

These tests made on the Timken dynamometer are instructive because they demonstrate the effect of both composition and microstructure on the service of brake drums under identical conditions. Each illustrates its own story of the mechanism of the breakdown of brake drum metal.

Scoring

This is shown to take place when the temperature gradient developed in the drum is not steep enough to set up the mechanism of re-

FIG. 32.—ETCHED STRUCTURE. (MAG. 100.)

versal of expansion and contraction of the metal itself to which reference has previously been made.

Scoring appears to proceed by frequent applications of the brake so that the heat from the last application is not dissipated completely—that is, any condition of braking which makes the drum do more work than originally intended of it.

Scoring also bears some relation to relative

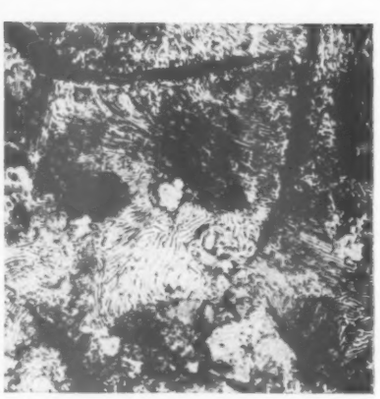


FIG. 33.—ETCHED STRUCTURE. (MAG. 500.)

hardness of the lining and the drum. Everything else being equal, a hard drum of the correct graphite structure will score less than a softer drum. Other causes of scoring have been dealt with earlier in this Paper.

Thermal Checking

This occurs when the temperature gradient between the braking surface and the centre of the drum is too steep for the drum to take care of. These tests indicate surface heating well above the critical change point. Apart from selection of a metal of such structure as will enable it to accommodate itself to alternating stresses at elevated temperatures, design of the drum, selection of the lining and adequate ventilation are all contributing factors.

Possibly the most important lesson of these tests is to show that any study of brake drum materials must be made under conditions approaching actual service operations as nearly as possible. To change the nature of a lining or the design of the drum or conditions of braking without making a new series of tests might be apt to give materially different results. It is this factor that makes the whole brake drum problem so difficult.

To-day not only the mechanical features of braking are changing rapidly, but vigorous research is being conducted by both the foundries making the brake drums and the manufacturers

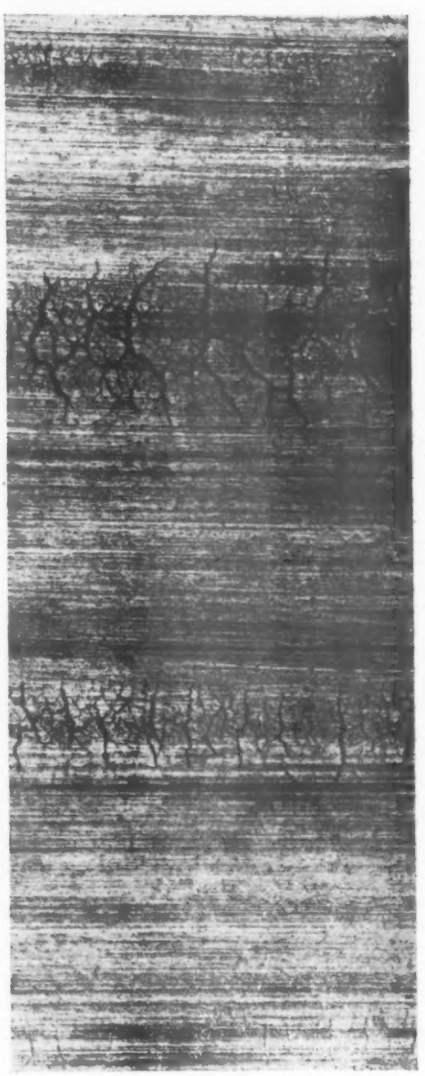


FIG. 34.—DRUM AFTER DYNAMOMETER TESTS.

making the linings. To-day so many compositions and structures of drums and linings are available that the only intelligent method seems to be that followed by Timken-Detroit Axle and the Fruehauf Trailer, and such companies who

are constantly conducting tests under closely controlled conditions. Even this, however, presents certain problems, for both the brake mechanism and the materials from which they are made are a long way from the ultimate.

Cast iron, whilst possibly the best of cheap brake drum materials, is still an indeterminate. Cast-iron brake drums of practically identical chemical composition may not possess the same structural make-up or the same physical properties. One batch may exhibit coarse graphite and some ferrite in a base structure of pearlite; another batch made from the same mixture and the same analysis may present an open pearlitic or even a closely pearlitic base structure with a different form of graphite, according to the degree of metallurgical control operating in any particular foundry and according to their methods of pouring and moulding.

Nearly all brake drum irons made with alloys, particularly those containing chromium, contain some free cementite and, as was shown, each structure responds very differently to scoring, thermal checking, and ultimate service life.

The primary considerations of a good brake drum material are:—(1) To select the correct structure in combination with the best mechanical properties for the particular service conditions to be encountered. (2) Uniformity—that is, every brake drum must have the same structure regardless of design or dimensions.

In the absence of these, fancy compositions of irons, the indiscreet use of alloys, the claim for high strength tests and the loose use of metallographic terms, are apt to be more misleading than informative. For example, brake drums on a logging trailer in the mountainous regions in the Northwest of America call for an exceedingly hard-wearing iron. The service is so severe on the long mountain grades that a tank of water is mounted on the trailer for the purpose of cooling off the drums. Such service and treatment produce both severe wear and premature thermal cracking.

For such a drum, a close form of pearlite that is thermally stable and a uniform and well-distributed condition of graphite structure will give the best results. Anything softer than this wears away rapidly, while excessive use of alloys producing free cementite causes deep thermal cracking and surface hardening.

In the case of ordinary trailer drums, the problem is primarily one of providing adequate stopping ability in view of the present tendency of overloading trailers. This is further complicated to a certain degree by preference for having the trailer brakes operate ahead of and more powerfully than those on the tractor.

In other words, trailer brakes are generally expected to do more work than those on the tractor. This may mean the use of a special high friction block, and such a material would cause rapid failure of drums having the structure shown by Nos. 3 and 4 materials used in the above tests.

On the other hand, for city bus drums where braking is relatively light but of high frequency, heat gradients from the braking surface to the centre of the drum are not so high as would be developed in the heavy braking of a loaded trailer, hence resistance to scoring is more important than resistance to thermal checking although a nice balance is necessary.

Thus it will be seen that an iron successful in one kind of service may fail in another. It is for this reason that Meehanite is finding wide favour in the manufacture of brake drums of all kinds, for this process renders available not only the control of both the structure and properties best suited to a particular service condition, but it enables quantity production under absolute and positive control. In other words, each type of Meehanite brake drum is made to a pre-determined structure and every drum made from that type of Meehanite will have exactly that structure and no other. Hence, when braking conditions have once been determined in the way of design, nature of brake lining, etc., a good wear-resisting curve of both the lining and drum is assured and braking surfaces remain flat and smooth.

FIG. 35.—NORMAL GRAPHITE STRUCTURE OF DRUM BEFORE TEST. (MAG. 100.)

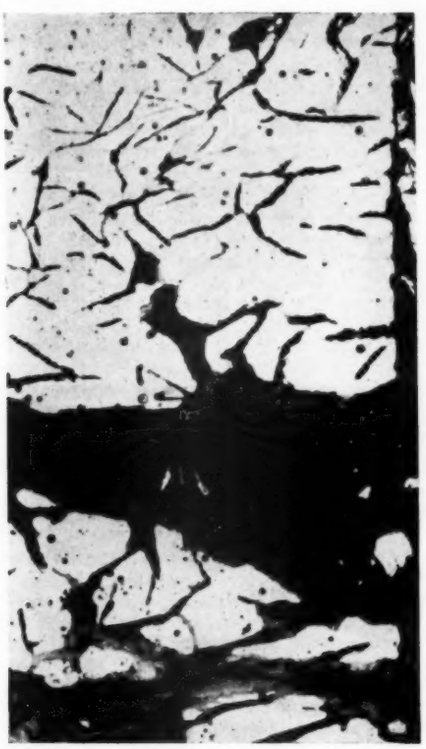


FIG. 36.—GRAPHITE STRUCTURE OF DRUM AFTER TEST UNETCHED. (MAG. 500.)

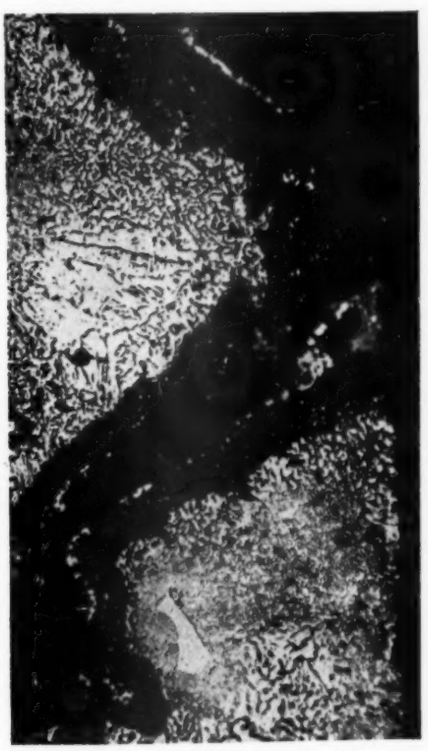


FIG. 37.—ETCHED STRUCTURE OF SURFACE OF DRUM AFTER TEST. (MAG. 500.)

In each case the working surface of the drum is at the right.

Some Factors Affecting the Resistance of Cast Iron to Deflection under Load at High Temperatures

(*Continued from page* 4.)

especially in the case of the low-silicon irons. Wastage of the specimens through scaling may be a contributory cause of the lack of rigidity of the two low-silicon irons. It will be noted from Fig. 2 that the deflection of the iron containing 3.28 per cent. Si was only slightly greater in the early stages of the test than that of the specimen which contained 6.62 per cent. Si. The sudden falling-off in the rigidity in the case of the lower-silicon bar as the test proceeded and as the load increased may be explained partly by this deterioration of the metal under heat. The scaling of the Silal bar was only superficial, as was also that of the other high-silicon irons. An interesting point is that these high-silicon irons, which, as already mentioned, are extremely brittle in the cold, were found to bend under prolonged stress at 850 deg. C. The bar containing 13.77 per cent. Si gave a permanent deflection of 0.86 in. at the free end of the test-piece under a stress of 1.7 tons per sq. in. after twelve days at this temperature. (The stress was increased at the rate of 0.2 ton per sq. in. every 24 hr. after 0.7 ton per sq. in. had been reached.)

The results of these tests show that additions of silicon of the order of 7 per cent. and more considerably increase the resistance of cast iron to deformation under load at high temperatures.

(*To be continued.*)

High Silicon-Molybdenum Iron for Hearth Plate Castings

According to "The Moly Matrix," the house organ of the Climax Molybdenum Company, cast irons commonly used to-day as hearth plates in heat-treating furnaces run the whole gamut from plain, unalloyed analyses to special heat-resisting compositions in which the alloying elements may exceed 25 per cent. of the total composition. Between these extremes, intermediate compositions are available, the costs of which are readily justified by their relatively long life and high operating efficiency.

A case in point is a high silicon iron recently developed at the Reliance Regulator Company, Alhambra, California, for the U.S. Electrical Motors, Inc., of Los Angeles. Previous to the adoption of the present specification, it was customary to replace the hearth plate in a certain electric furnace every month. The furnace, used for pack hardening gears, operated continuously at 800 deg. F. Failure of the cast iron hearth plate resulted primarily from growth of the iron when subjected to continuous operation at this temperature.

Convincing evidence of growth was at hand, since the plate usually warped so badly after a few weeks' service that it became impossible to insert the pack-hardening cylinders in the furnace in an upright position. Cracking was a common occurrence. In addition, the formation of scale in large quantities greatly impeded heat transfer. Several times the scale came in contact with the heating elements and the furnace burned out. When unalloyed hearth plates were being used, it was necessary to shut down the furnace each Monday morning to permit removal of the scale and cleaning the heating elements.

The high silicon analysis ultimately adapted was designed especially to resist the operating conditions encountered in this application. The composition of the new hearth plate is:—T.C, 2.6; C.C, 0.50 (approx.); Mn, 1.40; Si, 5.54; Cr, 2.24; Mo, 1.03; Ni, 1.23; and V, 0.12 per cent.

No heat-treatment is required, the castings being used in the condition in which they are shaken out of the moulds. The base metal was produced in a cupola under carefully controlled conditions. In this particular case, alloy additions were made both in the form of special pig-irons and by means of ladle additions.

It is interesting to observe how this combination of alloying elements acts as a positive check against premature failure resulting from growth. There is general agreement among most metallurgists that the growth of cast iron results from decomposition of the carbides and internal oxidation. Coarse-grained structures, cracks and the presence of large graphite flakes appear to accelerate this phenomenon. By properly balancing the alloying elements, fine-grained stable structures can be produced at will that are resistant to such oxidation.

The above alloy combination was purposely selected so that the transformation temperature exceeded the working temperature. In this manner, one potential cause of growth, allotropic transformation, was eliminated. (Unalloyed irons would undergo transformation both on heating to and cooling from this temperature.)

More specifically, in addition to stabilising the carbides, the chromium present in this iron helps to resist scaling. The high silicon-content, besides improving the resistance to scaling, increases the resistance to growth by raising the transformation temperature above the working range. High silicon also helps to prevent internal oxidation. Quantitatively, the specific effect of high silicon content on growth is shown by the following data published by the British Cast Iron Research Association:—

Growth of Cast Iron.

C per cent.	Si per cent.	Growth per cent.
2.1	3.7	0.923
2.1	5.3	0.571
1.95	5.6	0.247
2·5	6.1	0.011

Like chromium, molybdenum acts as a strong carbide stabiliser, and, as in the case of silicon, helps to raise the critical transformation temperature. Some beneficial effect on the size and distribution of the graphite flakes can be traced to the presence of molybdenum in combination with these other alloying elements. This, in turn, has an inhibiting effect on the passage of gases and the subsequent internal oxidation which might otherwise result in warpage and growth.

After nine months' service, the new alloy has shown no indication of ultimate failure. Warpage has been practically eliminated and the detrimental effects of scaling have been sufficiently reduced so as to eliminate completely the service interruptions previously incurred.

Judged both from the standpoint of cost and its ability to preserve production facilities intact, the new high silicon iron, stabilised by the presence of molybdenum and other alloying elements, is definitely proving its worth by meeting successfully these service requirements demanding outstanding resistance to heat. Some other practical heat-resisting applications for similar compositions would be tube supports for boiler or oil refinery installations, ash handling equipment where impact requirements are not severe and cooling plates for glass hot beds.

Improved Pickling

Dr. John Kronsbein, of the Electro-Chemical Engineering Company, Limited, in the course of a short article in "Tin and Its Uses," a quarterly review issued by Tin Research Institute, states that unlike the ordinary acid pickling solutions used for steel, the Bullard-Dunn bath does not cause etching, pitting, or permanent embrittlement, and a further advantage is that recessed areas of the work are descaled as completely as the more exposed surfaces. These features are explained by the presence of a small quantity of tin salts in the pickling liquor. As soon as any point on the steel surface is cleared of scale a film of tin is deposited on it and, although extremely thin, this film protects the metal from further acid attack, prevents direct solution of the iron in the acid, and eliminates pitting. The film of tin is sufficient protection to prevent steel surfaces from rusting during periods of storage in the course of manufacture, and has proved a very effective preparation for surfaces to be painted; indeed, both the adherence of the paint and the corrosion resistance of the steel work are improved.

Prospective users may naturally expect that the process will increase the cost of pickling because of the tin consumption; in fact, however, the tin consumption is exceedingly small and the silicon-iron anodes used prolong the life of the solution by as much as four or five times that of an ordinary immersion pickling bath.

Method of Working

The iron or steel article to be descaled is made the cathode in a hot dilute solution of sulphuric acid containing about 1 grm. per litre of tin sulphate. The current density used is of the order of 60 to 80 amps. per sq. ft., which causes copious evolution of hydrogen at the surface of the work and thereby assists the acid in removing the scale. The tin-ion concentration is so small that no tin is plated on scale, but as soon as scale is removed from the surface a protective film of tin is deposited, and there is no further attack by the acid at that point. This forces the acid to concentrate its attack elsewhere and greatly accelerates the pickling process.

The tin content of the bath is maintained by having a small percentage of the anodes of pure tin, but the majority of the anodes are of a high silicon iron. It is found that these anodes acquire a thin porous film of silica behind which the oxygen is released and eventually discharged without passing through the body of the solution. This inhibits the formation of ferric salts. It has been found that a concentration of about 3 ozs. of ferric salts per gall. slows down pickling and causes pitting, and that the special anodes used are an important factor in the economy of the process.

Current Foundry Problems

(*Continued from page 5.*)

of a Paper, and raised the point of metal wasted in splashing during pouring and as returned metal when too much was taken in the pouring ladles.

Crash Warnings

This subject brought forth interesting comments. MR. KAIN said that the spotter system was relied on at his plant. Neither power nor lighting was shut off and, if the warning was of long duration, the cupola was shut down until the raiders past signal was received.

MR. J. KING said that he also worked under the spotting system, but had always found men willing to work through a raid; at any rate, to the extent of dealing with metal in the ladles and giving any necessary furnace attention. All the members agreed with the latter statement, but MR. KAIN said he was of opinion that the authorities had not made the position clear as to what the men would get if killed or injured whilst working under these conditions.

MR. SHEPHERD remarked that executives had no legal right either to insist on or prevent a man taking shelter.

Cylinders and Liners in Cast Iron

MR. KAIN introduced this topic, saying that he had in mind plain cylinders and liners as distinct from, say, motor cylinders. He had used pencil gates and top running, also bottom running with tangential gates for larger types. Generally speaking, he favoured low-phosphorus, high-steel mixtures in conjunction with pencil gates and headers.

MR. J. FRANCIS remarked that he had some considerable experience in producing liners of various kinds and sizes. For plain unported liners he thought top running by means of equally spaced pop gates, with adequate sullage head, yielded satisfactory results. Low-phosphorus iron was not so important for a casting of uniform section, like a liner, as it was in the case of a complicated casting of varying section. Moreover, irons of medium phosphorus content gave better wearing properties. Top running favours directional solidification from the bottom upwards and by keeping alive the surface metal, helps sullage to rise free from the mould and core walls and find its way into the sullage head.

MR. HALL advocated the method of running in which branch gates from a common down stick enter the mould at two or three places, and inclined in an upward direction. Other members spoke favourably of this method, but Mr. Francis said that the change in place of entry of the metal stream as the mould filled did sometimes cause a ring of sullage to become trapped and make its appearance, on machining, as a continuous defect all round the liner.

The Acid Resistance of Finished Enamelware

RECOMMENDED METHOD OF TESTING

In 1939 the Chemical Resistance Test Sub-Committee appointed by the Joint Committee on Vitreous Enamelling (I.V.E.—B.C.I.R.A.), and consisting of Mr. J. W. Gardom (Chairman), Mr. G. H. Abbott, Mr. W. E. Benton, Mr. A. J. D. Black, Mr. A. England, Mr. S. Hallsworth, Mr. R. J. Slawson, Mr. W. Thomason (whose place was later taken by Mr. N. F. Parker), and Dr. G. T. O. Martin (Secretary), issued a recommended method of testing the acid resistance of vitreous enamels. At meetings where this Report was discussed, the need for a method of testing finished enamelware was confirmed, and the present report presents such a method, and describes the work leading to its evolution. Its relation to the test for vitreous enamel is discussed, and results for a number of commercial enamels tested by both methods are included. As a supplement to the report, a discussion of points arising from the previous Report is included.

The principle of the test for finished ware is not entirely original, as it is based on the well-known filter-paper spot test, but includes a few refinements and a new method of interpreting the results. It is believed to be simple enough for everyday use in the enamelling plant, and yet to be sound fundamentally, and capable of giving reproducible results.

Recommended Test for Finished Ware

Principle.—Acid solution is left in contact with the enamel surface for a given time, and the treated portion of the surfaces tested for its ability to retain finely divided dry materials of contrasting colour.

Surface to be Used.—Any suitable part of the piece of finished ware which is flat, or nearly so, and has a smooth and reasonably glossy surface.

Preparation of Surface.—Unless fresh from the furnace, the surface should be freed from any dirt or grease, by means of acetone, or ammonia followed by hot water.

Testing Solution.—The reagent used can be specified according to requirements, and should be a definite strength of a definite acid, and not a natural product of variable properties. If desired, two solutions can be used for control purposes, the enamel being affected by one but not by the other.

By using three solutions, four grades of resistance can be distinguished. The solutions recommended for this are:—

(1) 15 per cent. hydrochloric acid (50 per cent. by volume of the commercial acid).

(2) 10 per cent. citric acid (by weight of the crystalline substance).

(3) 2 per cent. acetic acid (by volume of glacial acetic acid).

Method of Application.—A round disc of ordinary filter paper is placed on the surface, and on top of this is placed a somewhat smaller disc of thicker, absorbent paper. (Sizes suggested are 3 and 2.5 cm., which can be obtained from the usual makers.) The solution is then dropped on to the paper until both discs are saturated. After fifteen minutes, the solution is washed off and the surface dried with a clean cloth.

Examination of Effect Produced.—Any obvious etching is a cause for rejection, but should be confirmed by the following method, which is used to make a decision in a doubtful case.

A small quantity of colour oxide (prepared by a precipitation process) is rubbed on to the dry enamel surface with a dry piece of chamois leather or velvet and the whole well rubbed with a clean dry surface of the same material. The acid-treated part of the surface is then examined in a good light. Small isolated specks of colour are not a cause for rejection, but there should not be any uniform colour stain over the whole of the acid-treated part, causing it to appear different from the surrounding enamel.

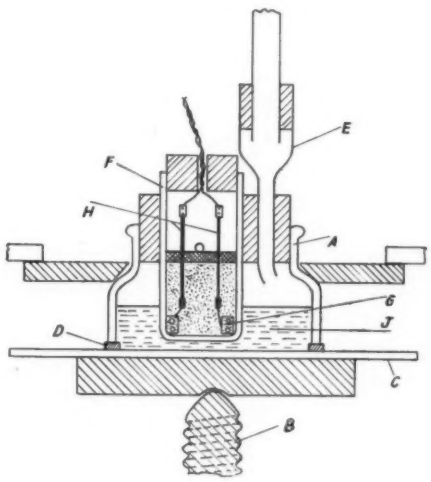


FIG. 1.—HOT ACID TEST FOR FLAT SURFACES

For white and light-coloured enamels, red or black oxide is recommended, while for black and dark-coloured enamels, a yellow oxide or a fine white powder, such as titanium oxide, is preferable.

Expression of Results.—If an enamel surface when treated by the method just described shows no visible colour stain, it can be called resistant to the particular solution employed.

Using the solutions 1, 2 and 3 given above, the enamel surface can be graded as:—

A if unaffected by all three solutions.
B if affected by 1 but not by 2 or 3.
C if affected by 1 and 2 but not by 3.
D if affected by all three solutions.

These have been found to correspond approximately as follows with the figures given by the previous test method for vitreous enamel:

A 0 to 40; B 40 to 200; C 200 to 400; D above 400.

Development of Test.—The discussion and experimental work leading to the adoption of this form of test are described below. The approach to a test for finished ware was first made by attempting to form a link between the hot acid test on a small bowl and a test similar in principle, but applied to the surface of a piece of finished enamelware. While it was considered that hollow-ware could be tested by a modification of the recommended method, some more complicated apparatus would be necessary for flat surfaces, while curved surfaces presented considerable difficulty.

Hot Acid Test for Flat Surfaces.—For some tests on flat test plates and flat stove parts, an apparatus of the type illustrated was used (Fig. 1). The principle was developed from a method described by Bryant (Journal of the American Ceramic Society, v. 20, October, 1937, page 317). It consists essentially of a shallow wide mouth glass bell-jar A (made from the top of a 2-lb. jam jar), which is clamped by a screw B to the enamelled plate C, a rubber washer D ensuring a good joint. The top of the bell jar is closed by a rubber bung, through which pass a glass adapter E leading to a reflux condenser, and a vitreosil tube F, 1½ in. in dia., with a flat bottom which is just above the enamel surface. This silica tube serves as an electric immersion heater, the heating winding G being concentrated as a coiled spiral around the circumference of the bottom of the tube, and connected to the mains *via* an ammeter and adjustable resistance by means of the copper leads H.

The area of enamel surface in contact with the acid solution J was 53 sq. cm., and the volume of acid used was 60 ml. The acid was brought to the boil as quickly as possible, and then kept boiling gently by a reduced heater current.

After one hour the solution was siphoned out, evaporated and ignited as in the recommended method of testing the acid resistance of vitreous enamel. As the samples used were too heavy to weigh accurately, the loss in weight was not determined, but the figures of Table I for

TABLE I.—*Showing Correlation of "Bowl" Test with Residue Weights.*

Enamel No.	Weight of Residue, in mg. per sq. dm.	
	Bowl.	Plate.
2	20	35
3	46	30
4	18	22
5	34	27
6	24	30

weights of ignited residue show, in most cases, fair agreement with those obtained from the tests of bowls coated with the same enamels.

This type of apparatus can be used on flat surfaces of cast iron or sheet iron parts. By cutting out a piece from a sheet iron part, it is possible to determine the loss in weight, but the metal normally used in practice is of rather heavy gauge for this purpose. This method of applying a boiling acid test to flat finished ware could not, however, be recommended for use under plant conditions, as it was considered to be essentially a laboratory test requiring skilled manipulation. The principle involved, and the type of apparatus used, may prove useful in other experimental work, but the Sub-Committee came to the conclusion that any test suitable

for use in plant or laboratory, or even in a warehouse or shop, must be a cold acid test, so that it can be quickly and conveniently applied. A test of the "spot" type with, if possible, a systematic method of interpreting the result, appeared to be the most useful.

Factors in Spot Tests with Cold Acid.—In the consideration of a test of this type, discussion was directed to three aspects of the question:—(1) Solution to be used; (2) method of applying the solution and (3) method of interpreting or classifying the results. Although discussion of all these subjects took place during the same period, it is convenient to discuss them separately here.

Testing Solution

Considering first the testing solution, it was anticipated that difficulty would be encountered with the more resistant types of enamel, as the search for a solution suitable for a wide range of enamels had led to a hot solution being used in the previously recommended method for testing enamel. As a further check on this, resistant enamels were tested with a number of acids at different strengths, and it was confirmed that some commercial enamels were not affected to any visible extent during a period which might reasonably be expected to be sufficient for a spot test. Acids used included hydrochloric, sulphuric, nitric, chromic and aqua regia, the range of concentrations covered being from 1 per cent. to full strength. Other acids tried, in the hope of finding a specific effect, were phosphoric, oxalic and perchloric. The only acid which would attack these enamels in the cold would be hydrofluoric, but there is no point in using this, as it attacks even pure silica. On very prolonged contact with strong mineral acids, certain coloured enamels are "bleached," that is, the colour is made lighter or even removed altogether. At the same time, only a "shadow" effect (see later) or perhaps a slight loss of gloss may be produced.

By a cold acid test, therefore, all enamels beyond a certain degree of acid-resistance are grouped together. The more resistant types of enamel used on domestic and sanitary ware will thus be rated the same as enamel for chemical plant, since the two cannot be distinguished by such a test.

Considering the enamels upon which an effect can be produced by a cold acid solution, it was thought possible that these could be suitably classified by means of a series of solutions such that an enamel would be attacked by all solutions below a certain number, but not by those above it. Such a series could be obtained either with one acid at different concentrations, or a series of acids of different strengths. Both methods were tried, but neither was found completely successful. For the first method, citric acid was chosen, since it is present in many fruit juices and is extensively used already for testing vitreous enamels. Using concentrations of 10, 5, 1, ½, 1/10th and 1/20th per cent., it was found that in cases where there was a pronounced attack by the 10 per cent. solution, the weakest solutions often produced a slight effect, while in other cases a faint effect was produced by all concentrations. (More will be said later about the types and degrees of effect produced by the action of cold acid solutions on enamel surfaces.) Using hydrochloric acid at concentrations of 16 down to 1 per cent., it was found that the relation between concentration and degree of attack was not uniform. The greatest activity was at about 4 per cent., both above and below this the effect was somewhat diminished, although this may not be true for all enamels.

For the arrangement of a series of different acids, it was necessary to have some idea of the strengths of a number of acids, so that a suitably graded series could be chosen. Measurements were made and *p*H/concentration curves plotted for hydrochloric, sulphuric, oxalic, phosphoric, malonic, tartaric, citric, formic, succinic, acetic, propionic, and phthalic acids. From these it was considered that 1 per cent. solutions of hydrochloric, oxalic, phosphoric, citric and succinic acids, 0.5 per cent. phthalic acid and 1 per cent. potassium hydrogen phthalate would form a suitably graded series, having *p*H values of 0.8, 1.3, 1.7, 2.2, 3.0, 3.2 and 4.0 respectively.

Spot tests were made with these solutions on test plates enamelled with different types of enamel, cast and sheet iron, wet and dry process, of various degrees of acid-resistance. This part of the investigation was combined with a trial of methods of assessing degree of attack, but this will be dealt with later. Here it is sufficient to state that while, for the most part, the results were in order of *p*H value, variable results were obtained with phosphoric acid, which sometimes had a smaller effect than citric acid and in one case a greater effect than oxalic acid. This would indicate some specific action of phosphoric acid rather than simple hydrolysis of silicates. Hydrochloric acid in some cases had no greater action than oxalic, but in others had a considerably greater action. The weaker acid solutions generally fell in the right order, but the differences between them varied to some extent.

The conclusion drawn from these experiments was that the composition of the enamel could influence considerably the degree of attack of some cold acid solutions, and that a numerical assessment of acid-resistance by means of a series of solutions of graded attacking power would be very difficult to devise. It was decided that, when giving the results of such a test, the acid solution used should always be specified. It was, however, considered advisable to give a lead by suggesting three or four solutions of increasing attacking power, so that the ware could be graded into four or five groups. For this purpose, 2 per cent. acetic acid (1), 10 per cent. citric acid (2), 3 per cent. oxalic acid (3), and 15 per cent. hydrochloric acid (4) were suggested, and a number of experiments were carried out with these solutions on some of the enamels which had been tested on the standard bowls by the previously recommended method, the results for which are given in Table II. This table gives the results for enamels of all types, covering a much wider range than that given in the previous report.

Table II includes the results previously published (Nos. 1-6), together with a number of others on enamels used for various purposes, on both cast and sheet iron. It is seen that the resistant enamels previously tested still rank high in resistance, but the non-resistant one can be considered moderately resistant, as the values for several others exceed its figures by a very wide margin, in one case being nearly three times as great. This forms a very good illustration of the great differences to be expected among commercial enamels, and the difficulty of devising a test to cover such a wide range.

While, in general, it is found that the degree of attack increases from solution A to B to C to D, in many cases the enamel is either attacked by all the solutions or by none of them. The general tendency is thus for an enamel either to be non-resistant (a figure of 400 or more), or very resistant (a figure of 40 or less). There seems to be no point in sub-dividing the intermediate classes into more than two types, as the effect of the 10 per cent. citric acid generally appeared to be about midway between that of the 2 per cent. acetic acid and the 15 per cent. hydrochloric acid, the 3 per cent. oxalic acid was omitted. The enamels tested by this method were thus classified as A, B, C or D, according to whether they were:

A unaffected by 15 per cent. hydrochloric acid;
B unaffected by 10 per cent. citric, but affected by 15 per cent. hydrochloric;
C unaffected by 2 per cent. acetic, but affected by 10 per cent. citric acid;
D affected by 2 per cent. acetic acid.

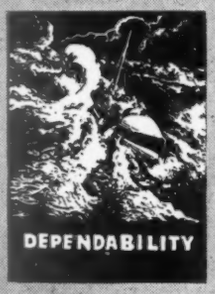
It was hoped to obtain a relation between the results of the hot acid test and those of the spot test using cold acid solutions. Such a relation can, however, only be regarded as approximate. For example, enamels 1 and 27 are placed in the reverse order by the two methods, and the same applies, but to a much smaller extent, to enamels 3 and 14. These variations are, no doubt, due to differences in enamel composition, particularly in the case of enamels 1 and 27, which would be very different. An approximate relation is given by: Values up to 40, Class A; values from 40 to 200, Class B; values from 200 to 400, Class C; values over 400, Class D.

Preparation of Surface.—It is essential in a spot test that the surface of the enamel is

(*Continued on page* 12.)

TABLE II.—*Test Result on a Range of Enamelled Parts.*

No.	Type.	Colour.	Use.	Bowl Test.		Spot Test Affected by Acid Solution.				Grade.
				Loss in Wt. Mg./sq. dm.	Residue. Mg./sq. dm.	1	2	3	4	
1	Sheet iron	White ..	Cooker parts	480	522	No	Yes	Yes	Yes	C
2	" "	White ..	" AR ..	18	20	No	No	No	No	A
3	" "	White ..	" " ..	38	46	No	No	No	No	A
4	" "	White ..	" " ..	14	18	No	No	No	No	A
5	" "	White ..	" " ..	30	34	No	No	No	No	A
6	" "	White ..	" " ..	26	24	No	No	No	No	A
7	Cast iron..	Grey ..	Chem. plant	25	20	No	No	No	No	A
8	Sheet iron	White ..	Cooker parts	1,184	1,244	Yes	Yes	Yes	Yes	D
9	" "	Green ..	" " ..	34	37	No	No	No	No	A
10	" "	White ..	Hollow ware	46	48	—	—	—	—	—
11	" "	White ..	" "	30	45	—	—	—	—	—
12	" "	White ..	" " ..	147	130	—	—	—	—	—
13	" "	Green ..	Reflectors (outside)	533	580	—	—	—	—	—
14	" "	Red ..	Signs ..	38	38	No	No	No	Yes	B
15	" "	Black ..	" ..	740	946	Yes	Yes	Yes	Yes	D
16	" "	Transparent	General ..	10	14	No	No	No	No	A
17	" "	White ..	Reflectors ..	429	466	—	—	—	—	—
18	" "	White ..	Hollow ware	599	604	—	—	—	—	—
19	" "	White ..	Signs ..	793	798	—	—	—	—	—
20	" "	White ..	Signs ..	17	20	—	—	—	—	—
21	" "	Green ..	Cooker parts	37	43	No	No	No	No	A
22	" "	White ..	" "	840	833	Yes	Yes	Yes	Yes	D
23	Cast iron..	White ..	Sanitary ware	—	782	Yes	Yes	Yes	Yes	D
24	" "	—	" "	—	36	No	No	No	No	A
25	Sheet iron	Transparent	Overglaze ..	100	104	—	—	—	—	—
26	Cast iron	Grey ..	Cooker parts	12	10	No	No	No	No	A
27	" "	Grey ..	" "	350	378	Yes	Yes	Yes	Yes	D



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The Week's News in Brief

Trade Talk

BARIMAR, LIMITED, welding specialists, give their new address as Kent House, 22/24, Peterborough Road, Fulham, London, S.W.6.

A WAGE INCREASE of 2s. 11½d. a week for brass and metal mechanics has been agreed upon following negotiations between the men's union and the Brassfounders' Association in Birmingham.

BRITISH FURNACES, LIMITED, of Chesterfield, have entered into an arrangement with the Standard Pulverised Fuel Company to take over the whole of the engineering and furnace side of that business.

THE BUSINESS OF BARTLE'S FOUNDRY & ENGINEERING WORKS, Carn Brea, Cornwall, a subsidiary of Smith Crofty, Limited, has been registered as a limited company, the whole of the shareholding being vested in the parent concern.

A RESEARCH SCHOLARSHIP of the value of £250 per annum, tenable for two years, has been founded by the Wrought Light Alloys Development Association to encourage and facilitate research in the application of light alloys to ship construction. Particulars of entry, which closes on July 31, can be obtained from the Secretary, Institution of Naval Architects, 10, Upper Belgrave Street, London, S.W.1.

PURCHASE TAX.—The following decisions regarding the liability of certain articles to tax are published as supplementary to those already given in Notice No. 78:—Class 7 (*b*), Domestic Appliances: Chargeable—Bread and bacon slicing machines, both of the guillotine and rotary types, the latter not exceeding 10 in. in diameter, hand operated (but not including machines fitted with an automatic feed).

FOLLOWING THE BOARD MEETING of the Staveley Coal & Iron Company, Limited, Sir William Bird, the chairman, whose forthcoming retirement will take place at the annual general meeting of the company in September, announced that his successor as chairman of the company would be the present managing director, Mr. D. N. Turner. Mr. H. H. Berresford would succeed Mr. D. N. Turner as managing director and Mr. T. A. McKenna, the present assistant commercial manager, would become the commercial manager.

MR. HERWALD RAMSBOTHAM, President of the Board of Education, speaking at Derby last Friday, said that as a result of a survey of technical education needs made some years ago, a programme of capital expenditure on new technical buildings amounting to £20,000,000 had been undertaken. Some progress was made before the war. Mr. Ramsbotham was opening a new engineering block of the Derby Technical College, and he stated that after the war there would be an urgent need in the interests of industrial and commercial prosperity, to secure an improved system of technical and commercial training.

Obituary

MR. PETER HAIG MUIRHEAD has died at Seahouses, Northumberland. Mr. Muirhead was born at Newcastle-upon-Tyne and entered the service of Armstrong, Whitworth & Company, Limited. He eventually became works manager of the Elswick and Scotswood Works of Vickers-Armstrongs, Limited.

New Company

(*From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.*)

Die Productions, Limited—Capital, £1,000. Engineers, manufacturers of and dealers in die products, etc. Directors: F. A., H. F., V. E., and D. Squire. 11, Hilmay Drive, Hemel Hempstead, Herts.

Contract Open

Cheltenham—Supply and laying of about three-quarters of a mile of 4-in. dia. spun-iron main, for the Rural District Council. Mr. John H. Haiste, consulting engineer, 22, Queen Square, Woodhouse Lane, Leeds, 2. (Fee £2 2s., returnable.)

Personal

ACTING FLIGHT LIEUT. WILLIAM MCFARLANE RUSSELL, who has been awarded the D.F.C., is the youngest son of Mr. John Russell, of Darlington, who is connected with the Darlington Forge, Limited, in a consultative capacity.

MR. J. GORDON MILLAR received presentations in London last Saturday in recognition of his services as the first chairman of the Council of the Institution of Factory Managers from 1938 till 1941. Mr. Millar is the general manager of Hardypick, Limited, Sheffield.

DR. H. L. GUY, Wh.Ex., F.R.S. (vice-president), has resigned from the Council of the Institution of Mechanical Engineers, and Eng. Vice-Admiral Sir George Preece, K.C.B., has been nominated to succeed him as vice-president. Major-General A. R. Valon, O.B.E., M.C., Wh.Ex., has been appointed to fill the consequent vacancy on the Council.

THE CHAIRMAN of the United Steel Companies, Limited, Sir Walter Benton Jones, Bt., has been appointed also managing director in place of Mr. N. H. Rollason, a director of the company who, by arrangement with John Summers & Sons, Limited, has been acting in that capacity since the sudden death of Mr. C. J. Walsh in the early part of the year and who has now resumed his duties as full-time managing director of John Summers & Sons, Limited. Three branch general managers, Mr. Langton Highton, Mr. C. F. Ward and Mr. Gerald Steel, have been appointed directors of the company.

MR. E. L. PAYTON, J.P., deputy chairman and financial director, was unanimously appointed chairman of the Austin Motor Company, Limited, in succession to the late Lord Austin, K.B.E., LL.D., J.P., the founder of the business which bears his name. Mr. Payton was elected to the board in April, 1922. In July, 1927, he was appointed to the Committee of Management, and became deputy chairman of the company in November, 1928. He is a vice-president of the National Union of Manufacturers, Midland Area, and represents Birmingham on the Grand Council of the Federation of British Industries.

MR. MAX KUNIANSKY, general manager, Lynchburg Foundry Company, Lynchburg, Va., who recently received the W. H. McFadden Gold Medal of the American Foundrymen's Association. Mr. Kuniansky is noted for his outstanding contributions to the developments in the grey-iron industry and for his many contributions on technical processes through Papers and committee work of the A.F.A. For years he has served on the committees of the Grey Iron Division of the Association, such as the Committee on Pig-iron Qualities, Committee on Recommended Practices for Cupola Mixtures, etc. At present he is chairman of the Sub-Committee on Scrap of the Cupola Research Committee. He is a director of the Chesapeake Chapter and has given many talks before chapters of the Association and before annual convention sessions. Mr. Kuniansky was born in Russia on March 30, 1899, and after emigrating to America entered the Georgia School of Technology, graduating in 1919 with the degree of B.S. in engineering chemistry. For a while thereafter Mr. Kuniansky was connected with the former Aetna Explosives Company, now the Hercules Powder Company, at the Birmingham, Ala., and Ishpeming, Mich., plants. He was also connected with the National Malleable Castings Company, at the Grant works in Chicago, and with the American Cast Iron Pipe Company, Birmingham, until 1923. Then he became associated with the Lynchburg Foundry Company, Lynchburg, Va., as chief chemist from 1923-28, then as works manager, later being made general manager of the company with headquarters at Lynchburg. Mr. Kuniansky, in addition to his activities in the A.F.A., has been prominent in the work of other technical and professional associations, particularly the American Society for Testing Materials.

Wills

PEECH, A. O., steel manufacturer, a director of the United Steel Companies, Limited	£57,476
ENTICKNAP, G. F., of Radcliffe, Lancs, representative in Manchester of the Skinningrove Iron Company, Limited, Saltburn	£9,101

Reports and Dividends

Beans Industries, Limited—Interim dividend on the ordinary shares of 10 per cent. (same).

Allied Ironfounders, Limited—Net profit for the year ended March 31 of £113,078, compared with £112,424 last year.

Glacier Metal Company, Limited—Net profit for the year ended February 29, £47,512 (£42,173); ordinary dividend of 7½ per cent. (same).

Anderston Foundry Company, Limited—Net profit to March 31, £4,696 (£8,079); dividend 3s. per £3 share (4s. 6d.); carried forward, £10,3 (£10,378).

W. & T. Avery, Limited—Net profit for the year to March 31 last, £130,661 (£151,098); final dividend of 10 per cent. on the ordinary shares, making 15 per cent. (same).

Dunswart Iron & Steel Works, Limited—Dividend at the rate of 5½ per cent. per annum for the period January 1, 1941, to June 30, 1941, equivalent to 6.6d. per share, on the preference shares.

Barrow Hematite Steel Company, Limited—Net profit for 1940, £83,191 (against £111,394); brought in, £19,064; dividend of 5 per cent. (same); to reserve, £50,000; carried forward, £16,893.

Robert Stephenson & Hawthorns, Limited—Net profit for 1940, £18,668 (against £16,676 for 1939); brought in, £4,994; dividend of 5 per cent. (against 4 per cent.); general reserve, £5,000; carried forward, £4,912.

Mason & Burns, Limited—Profit to March 31 last, £17,819; depreciation, £1,708; brought in £3,759; N.D.C., £252; income-tax and taxation reserve, £8,063; dividend of 20 per cent., £5,000; carried forward, £4,616.

Union Steel Corporation (of South Africa) Limited—Interim dividends of 4 per cent. (9.6d. per share) on the 8 per cent. participating preference "A" and "B" shares, and 3 per cent. (1.8d. per share) on the ordinary shares.

Revo Electric Company, Limited—Final dividend of 10 per cent., together with a cash bonus of 5 per cent., making a total distribution for the year ended March 31, 1941, of 20 per cent. compared with 5 per cent. for the preceding year; net profit, £53,501.

John Harper & Company, Limited—Net profit for the year to April 1, £70,547 (against £57,94 for 1939-40); taxes, £41,080 (£21,798); war damage insurance, £3,000 (nil); ordinary dividend of 1 per cent. (same); to general reserve, £7,000 (£11,529); carried forward, £10,538 (£10,298).

F. H. Lloyd & Company, Limited—Profit for the year ended March 31 last, £57,543 (against £54,24 for 1939-40); ordinary dividend of 10 per cent. (same); to reserve for taxation, £20,000 (£3,000); reserve for contingencies, £7,500 (£12,000); to general reserve, £5,000 (same); carried forward, £15,66 (£22,530).

Park Gate Iron & Steel Company, Limited—Gross trading profit to March 31 last, £236,47 brought in, £47,739; depreciation, £60,000; reserve for taxation, £90,000; debenture interest and sinking fund, £28,000; War Damage Insurance, £18,24 dividend of 4 per cent., £40,000; carried forward £47,971.

The Acid Resistance of Finished Enamelware

(*Continued from page* 10.)

perfectly clean and free from grease. The enamel surface should preferably be freshly prepared, *i.e.*, ware direct from the enamelling plant and which has not been in use. To clean the surface in readiness for the application of acid, a soft rag moistened with acetone has been found useful, while another good method is to wash with ammonia followed by boiling water and dry with a clean cloth.

(*To be continued.*)

Correction:

In Mr. McRae Smith's letter on "Moulding Practice for Hot-Forming Dies," published in last week's FOUNDRY TRADE JOURNAL, page 422, the analysis in the second column should read "T.C, 2.8 to 3.2," and not "T.C, 2.28 to 3.2," as printed. We hope this error has not caused any misapprehension.

WHEN ONLY **PRODUCTION** COUNTS

For the institutions we all hold dear, British Industry, both men and management, are working with an intensity and will-to-win unique in our history. Refractories cradle almost every item of war equipment—ships, planes, tanks, guns, and so on. Never before has the choice of suitable refractories held greater consequences. The life of furnace structures must reach its maximum, and repair time minimised. In the choice of a refractory—'G.R.' engineers can be of much assistance to you. A wealth of experience is backed by a comprehensive range of famous products, which—when selected and applied to suit service conditions—will yield maximum life and dependability. 'G.R.' invite your enquiries which will receive the most careful consideration.

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FIREBRICKS: *Glenboig Special, Glenboig Special Crown, Glenboig, Glenboig Crown, Castlecary, Dykehead, Gem, White Carr, Stour, Hycone, Alumantine, Hysilyn, Adamantine, Llangennech.*
BASIC BRICKS: *Spinella, Saxpyre, Supermag, Diazite, Dolomax.*
ACID-PROOF REFRACTORIES: *Obsidianite, Losol.*

INSULATION: *Amberlite* Bricks, Cement and Concrete.
SILICA BRICKS: *Lowood, Meltham, Allen, Quartex.*
CEMENTS: *Sintex, Durax, Pyrolyte.* PLASTICS: *Durax, Rotaline, Plastic K-N., Glendoline, Ground Ganister, Steel Moulders' Compositions.* SILLIMANITE: *Tank Blocks, Bricks and Cements.* SANDS: *Moulding, Brick Facing, Silica, Glass.*

Raw Material Markets

There is little change in the iron industry from week to week. Makers of light iron castings are still not getting much new business, while heavy-castings manufacturers have order-books extending over some months ahead, with the promise of a steady flow of new specifications in the future, owing to the preponderance of Government requirements in this trade. High-phosphorus iron is in ample supply, but low-phosphorus iron and hematite are not easy to secure.

Pig-Iron

MIDDLESBROUGH—Production of Cleveland foundry iron remains virtually suspended, local consumers receiving all the iron they require from furnaces in the Midlands. Northants and Derbyshire producers are able to give excellent service in this respect, so that the absence of local production is not a source of inconvenience. Light-castings makers are unable to record any improvement in the state of their order-books, and the outlook in this trade is not very promising. On the other hand, activity among makers of heavy engineering products is maintained on a very high scale, and these foundries find greater difficulty in securing their raw materials than is the case with other iron users. Consumers engaged on vital war work are able, with the co-operation of the authorities, to obtain sufficient iron to meet their current needs, but stocking facilities are rarely available.

There is still comparatively little hematite iron available in relation to actual demands, but many users are successfully adapting their mixtures to the use of refined qualities, high-phosphorus iron, and steel scrap, which are much more plentiful. Hopes are held that the output of hematite will be enlarged shortly, but priority demands are considerable, and will quickly account for any additional iron produced.

LANCASHIRE—In the aggregate, consumption of pig-iron in this district is quite large, the chief support being from speciality engineers, who are operating to capacity on urgent orders for Government departments and other bodies directly associated with the war machine. Deliveries from Derbyshire and other Midland furnaces have improved somewhat of late, and less delay is now experienced in securing supplies, though priority consumers have never been seriously affected. Difficult conditions continue to prevail among the makers of light castings, who, in most instances, are unable to maintain full-scale operations of their plants. Jobbing foundries, also, are not too well placed in the main, and most works could readily take on much more business.

MIDLANDS—Highly satisfactory conditions continue to obtain in the heavy engineering industry, in which a substantial volume of Government contracts is being handed out. Heavy castings producers cannot purchase all the low-phosphorus iron and hematite which they require, but this problem is being tackled in a very commendable manner by the utilisation of refined iron and also a certain amount of high-phosphorus material. The supply position in respect to hematite is particularly tight, and where necessary the Control are delivering imported iron. High-phosphorus iron is in ample supply, and some consumers have been able to build up stocks. Few additional orders are being placed in the light foundry trade, and works in this section are poorly situated.

SCOTLAND—A certain amount of imported pig-iron is being distributed among consumers in this area, owing to the rather slow rate of deliveries from the furnaces. Use of foreign iron is, of course, being restricted as far as possible, and only urgent business receives the benefit of this iron. Heavy engineers are booked up as far ahead as they can see at the present time, but the light foundry trade, on the other hand, is in a position to accept much more business. Unfortunately, new orders in this section are not coming to hand very freely, and short time cannot be avoided at the works. The desultory conditions are due largely to the virtual suspension of housebuilding. High-phosphorus iron is being delivered in sufficient quantities to meet all needs, the iron being purchased in the English Midlands.

Coke

While consumption of foundry coke is above the average level for the time of the year, ovens are able to assist users to lay down stocks, and the larger consumers, especially, are eager to augment their reserves. Thus, business is quite brisk, notwithstanding the curtailed export trade. The current price of Durham best quality fuel is 46s. 9d. per ton, f.o.t. at ovens.

Steel

Some surprise and not a little disappointment were caused by the authoritative statement that no increase would be made in steel selling prices as from July 1. Consequently, producers will be unable to compensate themselves for the expansion in output costs which has taken place since the last revision of quotations was made. Prices are, of course, a matter for the Control to decide, and this body is empowered to change the level of quotations at any time and without prior notice to the trade. Steelmakers appreciate that it is desirable to avoid any undue rise in selling prices, but many now consider that they are entitled to retrieve some of the higher production costs and are not concealing their disappointment at the decision to maintain existing prices after the end of the first half of the year. Steel plates are being taken up in large quantities by ship builders and repairers, tank and boiler makers, and wagon and locomotive manufacturers among a variety of other users, and the mills are mostly heavily booked over some time to come. Sheet makers, too, are enabled to operate to capacity and cannot, in many instances, accept further orders for some months to come. Quite prompt delivery of structural steel is being given and, although consumers are slightly less busy than they were a few months ago, their requirements remain at a fairly high level. It is expected that the census of steel stocks, undertaken by the Ministry of Supply on Monday last, will yield valuable information to the Government, such as was provided by the census taken at the end of last year.

Scrap

Judging from observations in London and other areas which have received the attentions of the Nazi air force, the clearance of demolition scrap iron and steel is still rather a slow procedure. The authorities have declared that the process has been speeded up threefold during the past few weeks, but it is evident that the situation calls for even greater effort. The Government has rightly gone to great pains and expense to make the public "scrap conscious," and has succeeded in producing large tonnages of domestic scrap metal for the furnaces, but it can hardly be expected that householders will respond to the full extent in this respect when every day they can see twisted girders, etc., lying among the rubble of buildings wrecked by bombs, in many cases as far back as last autumn.

Metals

COPPER—For a long time past the Control authorities have been exercising strict care in the distribution of copper, non-essential consumers having received scant attention. As we have pointed out before, this policy was not dictated by any actual shortage of supplies so much as the need to provide against an emergency arising. It would seem that the decision of the British Government to co-operate fully with the Government of the U.S.S.R. in the fight against Naziism may well create such a position, as the Soviet Union will require large tonnages of copper for her war machine, and, despite progress in her own production facilities in recent years, a considerable proportion of the Soviet's copper will have to be imported. It is probable that the United States will render assistance in any effort Great Britain may make to send copper to Russia; semi-finished or finished products may be despatched in addition to raw copper. American shipments may be made direct or *via* the United Kingdom, owing to the hazardous nature of the White Sea route. A simpler route for shipping from the United States to the Soviet Union would probably be to Eastern Russia, where cargoes could be transported by the Trans-Siberian Railway.

It is reported from America that the U.S. Defence Commissioners are considering a copper subsidy in order to encourage new production. Mines at present operating would continue to sell at a fixed price of 12 cents per lb., and any additional output from high-cost producers would bear a premium of about 2 cent.

TIN—Prices of tin in London have continued to decline; sales by smelters have been persistent and buyers have displayed a reserved attitude. It is now expected that as much tin as possible will be released for shipment to Russia by Great Britain and the United States, although, of course, the supply position of the latter will not permit large-scale deliveries to be made. It is understood that the agreement between the American Reconstruction Finance Corporation and the Metals Reserve Company on the one hand and the International Tin Committee on the other, covering the purchase of pig-tin during the six months' period beginning July 1, will be extended automatically for a further period of six months if the international scheme for the regulation of production and export is extended. The agreement is a continuation of a similar arrangement entered into with the I.T.C. in June of last year. Under the new arrangement, the Metals Reserve Company has agreed with the Committee that it will buy 37,500 tons of tin to be held as a reserve stock.

World production of tin in May last, according to the Statistical Bulletin of the Tin Research Institute, is estimated at 22,200 tons, compared with 17,100 tons in April. Production for the first five months was 96,000 tons, against 85,400 tons in 1940. United States deliveries totalled 10,490 tons in May, against 13,955 tons in April, and in the first five months of 1941 were 65,492 tons, compared with 41,384 tons in the corresponding period of 1940. Tin consumption of the United Kingdom was 1,991 tons in April, against 2,691 tons in March and 2,278 tons in April, 1940. World stocks of tin, including smelters' stocks and carry-over, increased by 3,693 tons during May to 57,140 tons at the end of the month. Stocks at the end of May, 1940, were 40,783 tons.

Tin prices on the London Metal Exchange during the past week have been as follow:—

Cash—Thursday, £257 10s. to £257 15s.; Friday, £257 to £257 5s.; Monday, £256 to £256 5s.; Tuesday, £256 10s. to £256 15s.; Wednesday, £256 10s. to £256 15s.

Three Months—Thursday, £261 to £261 5s.; Friday, £260 10s. to £260 15s.; Monday, £260 to £260 5s.; Tuesday, £260 10s. to £260 15s.; Wednesday, £260 15s. to £261.

SPELTER—Both in this country and in the United States supplies of zinc are on the tight side, so that response to any call which might be made by the Soviet authorities cannot be extensive. It is fairly certain that Russia in wartime will need much more spelter than she can produce. British Empire output is fully accounted for by the needs of the British Armed Forces, so that the extent of our assistance to Russia in this respect will probably be restricted to shipments of finished and semi-finished brass goods and zinc base alloys.

LEAD—While quite a large tonnage of this metal is going straight into the war machine, ample supplies are available, and a fair proportion of the demand from non-essential users is also being met.

Durability of Cast-iron Rolls

An investigation of the conditions affecting the durability of cast-iron rolls made by T. P. MAKEJEW, in "Teori. prakt. met.," shows that the durability may be multiplied by storing the rolls for from 6 to 7 months before being put into service. Suitable compositions for hardened sheet rolls over 500 mm. in dia. are 2.7 to 3 per cent. C, 0.4 to 0.5 per cent. Si, 0.45 to 0.6 per cent. Mn, 0.5 to 0.6 per cent. P, and up to 0.1 per cent. S, and for medium and thin section rolls 2.9 to 3.2 per cent. C, 0.5 to 0.6 per cent. Si, up to 0.6 per cent. Mn, 0.5 to 0.6 per cent. P, and up to 0.1 per cent. S. The fine structure at the centre of the roll and at the journals should consist of fine graphite in a pearlite matrix.

Whose side is your lighting on?

Inefficient lighting will "break through" your wartime production effort—to increase production you must install efficient lighting.

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RAW MATERIALS—PRICE LIST

Wednesday, July 2, 1941

COPPER*

	£	s.	d.
Electrolytic	62	0	0
High-grade fire-refined	61	10	0
Fire-refined of not less than 99.7 per cent.	61	0	0
Do., do., 99.2 per cent.	60	10	0
Black hot-rolled wire rods	65	10	0

TIN

	£	s.	d.
Standard cash	256	10	0
Three months	260	15	0
Settlement	256	15	0
Official average Cash, May	267	13	$11\frac{8}{11}$
Do. Three Months, May	266	8	$11\frac{8}{11}$
Do. Settlement, May	267	14	$3\frac{9}{11}$

SPELTER*

	£	s.	d.
G.O.B. (foreign) (duty paid)	25	15	0
Do. (domestic)	26	10	0
"Prime Western"	26	10	0
Refined and electrolytic	27	5	0
Not less than 99.99 per cent.	28	15	0

LEAD*

	£	s.	d.
Good soft pig-lead (foreign) (duty paid)	25	0	0
Do., do., (Empire and domestic)	25	0	0
English	26	10	0
Sheets, home	35	10	0
Do. export, f.o.b.	31	0	0
Pipes, home	35	0	0
Do. export, f.o.b.	31	10	0
Tea lead (nom.)		—	

ALUMINIUM

	£	s.	d.
Ingots	110	0	0
Wire, 10g.		nom.	
Sheets		nom.	
Circles, 20/24g.		nom.	

ZINC SHEETS, etc.

	£	s.	d.
Sheets, 10g. and thicker, ex works	39	2	6
Rolled zinc (boiler plates), ex works	37	2	6
Zinc oxide (Red Seal), d/d buyers' premises	28	7	6

ANTIMONY

	£	s.	d.
English, 99%, delivered	102	10	0
Foreign Regulus, duty paid	93	0	0
Chinese, prompt shipment, c.i.f.		nom.	

QUICKSILVER

	£	s.	d.
Quicksilver, ex w'hse London	47	15	0

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s.	0d.
Finished bars, 18% tungsten	3s.	10d.
Finished bars, 22% tungsten	4s.	4d.

Per lb. d/d buyers' works.

NICKEL SILVER, etc.

	Per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
To 10g.	1/7½ to 2/2½

with extras according to gauge.

Special 5ths quality turning rods in straight lengths, 1/6½ upwards.

* Maximum prices per long ton delivered to buyers' premises.

FERRO-ALLOYS AND STEEL-MAKING METALS

	£	s.	d.
Ferro-silicon (5-ton lots)—			
25%	21	0	0
45%	23	10	0
75%	36	10	0
Ferro-vanadium—			
35/50%	15/6 lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free	6/- lb. Mo.		
Ferro-titanium—			
20/25% carbon-free	1/9 lb.		
Ferro-tungsten—			
80/85%	5/1 lb.		
Tungsten metal powder—			
98/99%	5/2½ lb.		
Ferro-chrome—			
2/4% car.	—		
4/6% car.	47	0	0
6/8% car.	47	0	0
8/10% car.	—		
Ferro-chrome—			
Max. 2% car.	1/0¾ lb.		
Max. 1% car.	1/1½ lb.		
Max. 0.5% car.	1/1½ lb.		
70% carbon-free	—		
Nickel—99.5/100%	£190 to £195		
"F" nickel shot	175	0	0
Ferro-cobalt, 98/99%	8/9 lb.		
Metallic chromium—			
96/98%	3/9 lb.		
Ferro-manganese—			
76/80% loose	18	10	0
76/80% packed	20	0	0
Metallic manganese—			
94/96% carbon-free	1/9 lb.		

Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.

SCRAP*

	£	s.	d.	£	s.	d.
SOUTH WALES—						
Short heavy steel, not ex. 24-in. lengths	4	2	0	to 4	4	6
Heavy machinery cast iron				4	7	0
Ordinary heavy cast iron				4	2	0
Cast-iron railway chairs				4	7	0
Medium cast iron				3	18	3
Light cast iron				3	13	6
MIDDLESBROUGH—						
Short heavy steel	3	19	9	to 4	2	3
Heavy machinery cast iron				4	11	9
Ordinary heavy cast iron				4	9	3
Cast-iron railway chairs				4	9	3
Medium cast iron				3	19	6
Light cast iron				3	14	6
BIRMINGHAM DISTRICT—						
Short heavy steel	3	14	9	to 3	17	3
Heavy machinery cast iron				4	12	3
Ordinary heavy cast iron				4	7	6
Cast-iron railway chairs				4	7	6
Medium cast iron				4	0	3
Light cast iron				3	15	3
SCOTLAND—						
Short heavy steel	3	19	6	to 4	2	0
Heavy machinery cast iron				4	14	3
Ordinary heavy cast iron				4	9	3
Cast-iron railway chairs				4	14	3
Medium cast iron				3	17	3
Light cast iron				3	12	3

* Delivered free to consumers' works in England and Wales. For deliveries of cast-iron scrap free to consumers' works in Scotland, the above prices less 3s. per ton, but plus actual cost of transport or 6s. per ton, whichever is the less. All prices: Plus 3½ per cent. dealers' remuneration: 50 tons and upwards over three months 2s. 6d. extra.

PIG-IRON*

N.E. COAST (d/d Tees-side area)—	
Foundry No. 1	131/-
„ No. 3	128/-
„ No. 4	127/-
Forge No. 4	127/-
Hematite No. 1	138/6
Hematite M/Nos.	138/-
N.W. COAST—	
Hem. M/Nos. d/d Glasgow	138/6
„ d/d Birmingham	150/-
MIDLANDS (d/d Birmingham dist.)—	
Staffs No. 4 forge	129/-
„ No. 3 fdry.	130/-
Northants forge	126/6
„ fdry. No. 3	127/6
„ fdry. No. 1	130/6
Derbyshire forge	129/-
„ fdry. No. 3	130/-
„ fdry. No. 1	133/-
Phosphorus 0.5% to 0.75%	137/6
Phosphorus 0.1% to 0.5%	140/6
SCOTLAND—	
Foundry No. 1, Grangemouth	127/3
„ No. 3, Grangemouth	124/9
Cleveland No. 3, Glasgow	131/-
„ „ Falkirk	128/-
Scottish hem. M/Nos. d/d	138/6
SHEFFIELD (d/d district)—	
Derby forge	126/6
„ fdry. No. 3	127/6
Lincs forge	126/6
„ fdry. No. 3	127/6
W.C. hematite	144/-
LANCASHIRE (d/d eq. Man.)—	
Derby fdry. No. 3	133/-
Staffs fdry. No. 3	133/-
Northants fdry. No. 3	131/6
Cleveland fdry. No. 3	133/-
Cylinder and Refined Irons.	
North Zone	174/-
South Zone	176/6
Refined Malleable.	
Birmingham and S. Staffs	171/6
Cold Blast.	
South Staffs	220/6

* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms and Slabs.

	£	s.	d.
BASIC:			
Soft, u.t., 100-ton lots	12	5	0
Tested, up to 0.25% C.	12	10	0
Tested, 0.25 to 0.33% C.	12	12	6
Tested, 0.33 to 0.41% C.	12	15	0
Hard (0.42 to 0.60% C.)	13	17	6
„ (0.61 to 0.85% C.)	14	7	6
„ (0.86 to 0.99% C.)	14	17	6
„ (1% C. and up)	15	7	6
Silico-manganese	16	5	0
Free-cutting	14	10	0
SIEMENS MARTIN ACID:			
Up to 0.25% C.	15	15	0
Case-hardening	16	12	6
Silico-manganese	16	5	0

Billets, Blooms and Slabs for Forging and Stamping.

Basic soft, up to 0.25% C.	13	17	6
Basic hard, 0.41 to 0.60% C.	14	10	0
Acid, up to 0.25% C.	16	5	0

Other Semi-products, etc.

Tin bars	12	2	6
Sheet bars	12	2	6
*Wire rods, soft basic	17	7	6
„ hard basic	21	2	6
„ free-cutting	20	2	6
„ acid	24	13	6

* Subject to rebate.

FINISHED STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel bars, sections, plates, joists and hoops is obtainable in the home trade under certain conditions.]

	£	s.	d.
Plates, ship (N.E. Coast)	16	3	0
Boiler plts. (N.E. Coast)	17	0	6
Chequer plts. (N.E. Coast)	17	13	0
Angles, over 4 un. ins.	15	8	0
Tees, over 4 un. ins.	16	8	0
Joists, 3 in. × 3 in. and up	15	8	0
Rounds and squares, 3 in. to 5½ in.	16	8	0
Rounds under 3 in. to ¼ in. (untested)	17	12	0
Flats—over 5 in. wide	15	13	0
„ 5 in. wide and under	17	12	0
Rails, heavy, f.o.t.	14	10	6
Hoops	18	7	0
Black sheets, 24 g. (4-t. lots)	22	15	0
Galv. cor. shts. („)	26	2	6
Galv. flat shts. („)	26	12	6
Galv. fencing wire, 8g. plain	26	17	6

FINISHED IRON

	£	s.	d.
CROWN IRON:			
England and Wales	15	12	6
Scotland	15	12	6
Ireland, f.o.q.	16	5	0
No. 3 BARS:			
England and Wales	12	10	0
Scotland	13	12	6
Ireland, f.o.q.	13	2	6
No. 4 BARS:			
England and Wales	13	0	0
Scotland	13	17	6
Ireland, f.o.q.	13	12	6
STRIP:			
England and Wales	17	0	0
STAFFS MARKED BARS, f.o.t.	18	10	0

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.84
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang., seaboard	120.00
O.-h. rails, h'y, at mill	40.00
Billets	34.00
Sheet bars	34.00

	Cents
Iron bars, Chicago	2.25
Steel bars	2.15
Tank plates	2.10
Beams, etc.	2.10
Wire rods	2.00
Skelp, grooved steel	1.90
Steel strip	2.10
Steel sheets	2.10
Sheets, galv., 24 g.	3.50
Wire nails	2.55
Plain wire	2.60
Tinplates, 100-lb. box	$5.00

COKE (at ovens)

Welsh foundry	48/9 to 50/3
„ furnace	36/9 to 38/9
Durham foundry	46/9
„ furnace	36/9
Scottish foundry	48/6 to 52/6
„ furnace	36/9

TINPLATES

I.C. cokes	20 × 14 per box		30/9
„	28 × 20 „		61/6
„	20 × 10 „		44/3
„	18¾ × 14 „		32/-
C.W. „	20 × 14 „		28/6
„	28 × 20 „		57/-
„	20 × 10 „		42/3 to 42/9
„	18¾ × 14 „		30/- to 30/6

NON-FERROUS SCRAP
(Official Maximum Prices, per ton ex Works.)

	£	s.	d.
Bright untinned copper wire, in crucible form or in hanks	57	10	0
No. 1 copper wire	57	0	0
No. 2 copper wire	55	10	0
Copper firebox plates, cut up	57	10	0
Clean untinned copper, cut up	56	10	0
Braziery copper	53	10	0
Q.F. process and shell-case brass, 70/30 quality, free from primers	49	0	0
Clean fired 303 S.A. cartridge cases	47	0	0
70/30 turnings, clean and baled	43	0	0
Brass swarf, clean, free from iron and commercially dry	34	10	0
New brass rod ends, 60/40 quality	38	10	0
Hot stampings and fuse metal, 60/40 quality	38	10	0
Admiralty gunmetal, 88-10-2, containing not more than ½ per cent. lead or 3 per cent. zinc, or less than 9½ per cent. tin	72	0	0

NEW BRASS TUBES, etc.

	Per lb.
Solid drawn tubes	13¾d.
Brazed tubes	15¾d.
Rods, drawn	11¼d.
Rods, extd. or rlld.	8¾d.
Sheets to 10 w.g.	10¾d.
Wire	10¾d.
Rolled metal	10d.
Yellow metal rods	8¼d.

COPPER TUBES, etc.

Solid drawn tubes	15d.
Brazed tubes	15d.
Wire	9¾d.

PHOSPHOR BRONZE

	Per lb. basis
Strip	13¼d.
Sheet to 10 w.g.	14¼d.
Wire	15¼d.
Rods	15¼d.
Tubes	21d.
Castings	17d.

Delivery 3 cwt. free.
10% phos. cop. £35 above B.S.
15% phos. cop. £40 above B.S.
Phosphor tin (5%) £40 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

AVERAGE MONTHLY PRICES OF UNMARKED BARS (SOUTH STAFFS)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1906	7 0 0	7 5 0	7 5 0	7 5 0	6 17 6	6 15 0	6 12 6	6 10 0	6 10 0	6 12 6	6 16 3	7 3 9	6 17 8
1907	7 3 9	7 5 0	7 5 0	7 5 0	7 5 0	7 7 6	7 5 0	7 7 6	7 7 6	7 7 6	7 7 6	7 5 0	7 5 11
1908	7 2 6	7 0 0	7 0 0	7 0 0	6 15 0	6 7 6	6 5 0	6 2 6	6 2 6	6 2 6	6 2 6	6 0 0	6 10 0½
1909	6 0 0	6 0 0	6 0 0	5 17 6	6 0 0	6 0 0	6 0 0	5 17 6	6 0 0	6 2 6	6 2 6	5 17 6	5 19 9
1910	6 2 6	6 3 4½	6 7 6	6 7 6	6 7 6	6 7 6	6 6 6	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 7
1911	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 10 0	6 12 6	6 16 6	6 7 0
1912	6 18 9	7 1 10	7 2 6	7 8 9	7 18 0	8 0 7	8 2 6	8 3 6	8 5 0	8 6 3	8 7 6	8 8 9	7 17 0
1913	8 11 6	8 10 7½	8 10 0	8 8 1½	8 2 0	8 0 0	7 17 6	7 11 6	7 8 9	7 5 6	6 18 1½	6 17 6	7 16 9
1914	6 17 6	6 15 7½	6 12 6	6 10 0	6 10 0	6 10 0	6 10 0	7 11 10½	8 0 0	7 12 6	7 5 7½	7 6 3	7 1 0
1915	7 11 6	8 5 11	8 8 9	9 6 0	10 3 2	10 19 2	11 12 6	11 13 1½	11 13 9	11 14 3	12 1 10½	13 0 9	10 6 0½
1916	13 7 6	13 10 8	13 12 9½	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 3 9
1917	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0½
1918	13 15 0	13 17 3	13 17 6	13 17 6	13 17 6	13 17 6	13 17 6	14 15 0	14 15 0	14 15 0	14 15 0	14 15 0	14 4 5
1919	15 10 0	16 5 0	17 15 0	17 15 0	20 15 0	21 0 0	21 0 0	22 0 0	22 0 0	22 0 0	22 7 6	22 12 6	20 1 8
1920	24 7 6	24 10 0	25 10 0	27 10 0	29 5 0	31 0 0	31 10 0	31 10 0	31 10 0	31 10 0	31 10 0	29 7 6	29 1 8
1921	26 17 3	25 0 0	23 0 0	21 0 0	19 0 0	18 5 0	16 0 0	16 0 0	15 14 0	14 0 0	13 6 8	13 0 0	19 4 5½
1922	13 0 0	12 3 9	11 14 0	11 11 10½	11 5 0	11 3 6	11 2 6	11 5 0	10 17 2½	10 16 3	10 13 0	10 12 6	11 7 0½
1923	10 16 10½	11 3 1½	12 2 6	12 8 9	12 11 6	12 1 3	11 15 11½	11 15 0	11 15 0	11 15 0	12 13 6	12 8 3	11 18 10½
1924	12 9 6	12 10 0	12 10 0	12 15 7½	12 17 6	12 17 6	12 17 6	12 17 6	12 17 6	12 14 0	12 12 6	12 12 6	12 14 3½
1925	12 12 6	12 12 6	12 12 6	12 12 6	12 12 6	12 7 6	12 7 6	12 7 6	12 4 6	11 18 6	11 13 9	11 13 0	12 6 2
1926	11 7 9½	11 5 0	11 5 0	11 5 0	11 3 9	11 3 9	11 5 0	12 0 0	13 0 0	*	15 7 6	12 10 0	12 0 2
1927	12 6 3	12 2 6	11 14 0	11 0 0	10 18 9	10 13 6	10 12 6	10 5 0	9 16 0	9 15 0	9 13 9	9 12 9	10 14 2
1928	9 12 6	9 12 6	9 11 0	9 10 0	9 8 4	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 3 6	9 1 3	9 7 0
1929	9 0 0	9 2 6	9 5 7½	9 9 4½	9 10 0	9 17 6	10 2 6	10 2 6	10 2 6	10 0 6	10 3 9	10 5 7	9 15 2½
1930	10 7 6	10 7 6	10 7 6	10 6 10½	10 6 3	10 5 0	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 4 7½
1931	10 2 6	10 0 0	10 0 0	10 0 0	9 18 1½	9 17 6	9 17 6	9 17 6	9 17 6	9 17 6	9 17 6	9 16 10½	9 18 0½
1932	9 15 0	9 15 0	9 15 0	9 15 0	9 13 9	9 11 3	9 10 0	9 10 0	9 10 0	9 6 3	9 5 0	9 5 0	9 10 11½
1933	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0
1934	9 5 0	9 8 1½	9 12 6	9 12 6	9 12 6	9 12 6	9 12 6	9 12 6	9 12 6	9 12 6	9 12 6	9 12 6	9 11 6
1935	9 12 6	9 12 6	9 12 6	9 12 6	9 12 6	9 12 6	9 12 6	9 12 6	9 12 6	9 12 6	9 12 6	9 12 6	9 12 6
1936	9 12 6	9 15 0	10 2 6	10 2 6	10 2 6	10 2 6	10 6 3	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 4 5½
1937	10 10 0	10 10 0	11 17 6	11 17 6	11 17 6	11 17 6	12 4 6	13 5 0	13 5 0	13 5 0	13 5 0	13 5 0	12 4 11½
1938	13 5 0	13 5 0	13 5 0	13 5 0	13 5 0	13 5 0	13 5 0	13 5 0	15 3 0	13 5 0	13 5 0	13 5 0	13 5 0
1939	12 5 0	12 5 0	12 5 0	12 5 0	12 5 0	12 5 0	12 5 0	12 5 0	12 5 0	12 5 0	12 15 0	12 15 0	12 6 8
1940	12 15 0	12 17 6	12 17 6	13 16 3	14 2 6	14 2 6	15 2 6	15 2 6	15 2 6	15 2 6	15 12 6	15 12 6	14 7 2½
1941	15 12 6	15 12 6	15 12 6	15 12 6	15 12 6	15 12 6	—	—	—	—	—	—	—

* No quotation available owing to strike.

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